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Fianl Report

R-88-05-0316

Drought Proofing Cattle Feed Supplies With Kochia

Funded by
The Agriculture Development Fund

October, 1990

DROUGHT PROOFING CATTLE FEED SUPPLIES WITH KOCHIA

by

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for

The Western Canada Kochia Association

funded by

The Agriculture Development Fund

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SRC Publication No. R-1550-7-E-90 October, 1990

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ACKNOWLEDGEMENTS

This study was funded by the Saskatchewan Agriculture Development Fund in a contract to the Western Canada Kochia Association.

We thank the many farmers and veterinarians who participated in the surveys reported in Chapter 1 and Chapter 2.

Additional financial support was provided by the Saskatchewan Research Council and the Agriculture Canada Research Station at Swift Current.

ABSTRACT

Research and a 100-farmer survey found methods to plant, fertilize, harvest and feed kochia hay to beef cows. Yields were up to 10940 kg DM/ha (5.6 tons/ac in research studies on saline soils, and as high as 3 tons/ac on farms. Fall cultivation and fall or early spring seeding and fertilization gave the highest yields. Nitrogen fertilizer increased yields, protein and oxalate. Yields were highest and stem size smallest at highest plant densities (330-470 plants/m^2) tested. Feeding trials and the farm survey found that the best maturity stage to harvest kochia was late bud or flowering.

EXECUTIVE SUMMARY

The objectives of this study of kochia were to attempt to develop reliable methods to plant, fertilize, harvest and feed kochia, grown on saline and non-saline soils. This was done by investigating preceding tillage, seed treatments, planting density, planting time, soil disturbance, interplanting with barley, and harvesting stage of maturity and its effect on feed intake and feed value in ruminant animals. In addition, we measured kochia's ability to germinate under different rainfall patterns. The feed value and presence of toxic factors in kochia were investigated under the various growing conditions studied.

Farmer Survey Results

An important method of investigating these effects was a survey of 100 farmers who had fed kochia to about 9500 cattle over the winter of 1988-1989 after the major drought of 1988. The survey found that kochia could be a useful part of cattle feed supplies, provided that it was kept at less than 50% of the ration, and that it was only fed as a part of the maintenance ration of beef cows. Most problems, of the relatively few that happened, occurred in situations where kochia was more than 50% of the ration, and/or where it was fed to growing animals. Kochia was harvested at the late bud or flowering stage of maturity to give the best forage. The sharp, woody stems of late maturity (late flower or early seed) kochia caused problems in feeding and acceptability. Kochia was best harvested with equipment that crimped the stems to hasten drying. Care needed to be taken to use baling equipment and conditions to minimize leaf loss. Farmers yields, mainly of wild kochia grown on cultivated saline soils, were in the range of one-half to three tons/acre. Kochia proved to be an important emergency feed in the drought of 1988, with an estimated feed value of about $7 million based on the estimated number of farmers who fed kochia.

A survey of veterinarians was also conducted, seeking reports of problems where kochia was suspected of being a factor in illness or death of livestock. Of the veterinarians who responded and who had contact with herds being fed kochia, 50% reported no problems. Where problems occurred, they were generally in herds being fed high levels of kochia (more than 50%) with little in the way of good quality other forages or grain. Some problems were associated with herds where the water supply was high in sulfates. Coarse, over-mature, woody-stemmed kochia was also the cause of some physical injury problems and poor palatability.

Research Results

Removal of the outer layers of the kochia seed (the papery outer calyx and pericarp) by simple mechanical rubbing increased the forage yield significantly and also the protein content of the hay. Selection for large seed size increased the height of the kochia at forage harvest, but did not increase the yield or feed value. When selected, non-weedy lines of kochia are available, simple seed treatment to remove the calyx should tested further as a method to increase yields.

A planting density study in a pot experiment in non-saline soil showed that kochia stems could be reduced in size to 0.45 cm (and likely made more palatable) by planting at densities of 326 plants/m^2 compared to lower densities. This could be done without sacrifice in yield or feed value. A planting experiment in the field on saline soil found that yields were the greatest at the highest planting density of 470 plants/m^2. No effects of planting density were found on protein content, digestibility, ash content, or the amounts of possible toxins in the form of nitrate, alkaloid, oxalate or saponin. The conclusion of these two studies was that increasing planting densities to 400 plants/m^2 increased forage yield, decreased stem size, and had no effect on feed value.

Four times to cultivate, fertilize and seed kochia were tested on saline soil. The procedures were: 1) fall cultivation, naturally seeded (area previously in kochia),spring fertilized, 2) fall cultivated, fall seeded and fertilized, 3) early spring cultivated, fertilized and seeded, 4) late spring cultivated, fertilized and seeded. In 1988, the best yield was obtained from method 3) at 7520 kg/ha dry matter (DM). In 1989, the best yield was from method 2) at 10940 kg/ha DM. In both years the poorest yield was obtained from method 4). The conclusions from this study were that cultivation is needed to control winter annuals, and that it is necessary to seed into a firm moist seed bed, with adequate fertilization. A double-disc drill was used to plant kochia in all the experiments.

Four rainfall regimes were tested in the greenhouse to determine the effect on the germination of kochia in saline soil. Kochia did not emerge from a dry soil unless there was a subsequent rainfall to stimulate germination. If rainfall was followed by a dry period, the seedlings survived. If the seed was planted more than 1 cm below the surface, seedlings did not emerge. In the field, kochia obtains these conditions (with shallow planting into a firm seed bed) in early spring, when soils are still damp. This was reflected in the time of planting experiments. Kochia seedlings are known to be very frost tolerant, so very early spring emergence is not a problem.

Nitrogen fertilizer significantly increased yields of kochia in three years of testing, with the largest effects usually seen with the first 56 kg N/ha. Crude protein, ash and oxalate were all significantly increased with nitrogen fertilizer. The digestibility of the kochia was not increased by nitrogen fertilizer. High nitrate content was only a problem in 1989, and then only at the highest fertilizer level (168 kg N/ha), well beyond the most economical rate. Thus the effects of phosphorous fertilizer levels was not investigated, since these were only to be varied to attempt to control nitrates to acceptable limits.

Interplanting of kochia with barley was studied in non-saline soil in a pot experiment outdoors. At various percentages (30,50,70) of barley in the mixture, barley easily outcompeted kochia, and suppressed kochia growth to low levels. A field experiment to interplant kochia with barley, and compare to 100% barley and 100% kochia on saline soil suffered from low yields. The 100% kochia had the highest yields (not tested for significance), and the highest organic matter digestibility, ash, protein, oxalate and nitrate. The mixture of kochia and barley had intermediate feed values and the pure barley the lowest.

The study on feeding kochia at three stages of maturity to sheep and cattle encountered several problems. It was not possible to obtain all three stages of maturity at the same site. Difficulties in storing and handling the kochia bales to be fed to the cattle led to major loss in feed value. Therefore, only the sheep trial results were considered in detail. The material cut on July 28th at flowering had the highest crude protein content. When this material was fed as 50% of the diet with Altai wild rye grass hay, digestible protein intake was higher than with kochia hays of lower protein content cut on August 4th or September 14th (flowering and mature seed stages respectively). Digestible energy intakes were similar on all three diets. The mature kochia was fed at 100% of the diet to test whether mature kochia could be tolerated at higher levels than more immature kochia. Other trials have shown that earlier stages of maturity kochia, e.g., late bud or early flower, have higher protein and digestibility, and result in higher intakes of digestible protein and energy. Nitrogen retention was higher with younger kochia with the highest crude protein content. Nitrogen retentions were improved when kochia was diluted with other feeds to less than 50% of the ration.

The factors affecting the levels of various feed value parameters and potential toxins in kochia were studied as part of the experiments described. Increasing nitrogen fertilizer increased crude protein, ash contents, and oxalates. Nitrates tended to increase, sometimes to serious levels, at high rates of nitrogen fertilizer. Early stage of maturity kochia tended to have more protein, higher digestible organic matter and ash. Leaves stayed high in digestibility at all stages of maturity. Stems were low in digestibility and increased in proportion of the total forage as the kochia matured. Alkaloids did not follow any recognizable pattern. The most recent work in Alberta showed that the alkaloid found (p-methoxyphenethylamine) was not toxic to rats at the levels found in kochia. The levels of two sulfur amino acids in kochia forage (methionine and cystine) were much lower than in forages such as alfalfa. Feeding studies should test the effects of methionine and cystine supplementation on the feed intake and nitrogen retention of kochia in sheep. The kochia should be fed at no more than 50 % of the diet.

There is evidence from these studies that the route to obtaining good stands of kochia on saline soil for several years in a row is to cultivate the soil each year in the fall, plant kochia in the fall or early spring into a firm seed bed , and fertilize to maintain soil fertility. Other studies are needed to evaluate crop rotations on saline soils. E.g., can kochia be used as the first year crop, followed by perennial forages such as tall wheat grass or alfalfa?

The next stage in the development of kochia into a tame forage crop is to select varieties with reduced tendencies to spread seed (i.e., non-weedy) and with improved forage qualities such as increased leafiness. Such studies have started at the Swift Current Research Station of Agriculture Canada.

Impact of Kochia Use on Saskatchewan Agriculture in the Winter of 1988-89

The information to assess the impact of kochia in helping to alleviate the feed shortage in southern Saskatchewan as a result of the drought in 1988 was obtained from several sources:

- phone interviews with Mr. Barry Peterson, Mr. Bob Klemmer and Mr. Len Piggott, livestock specialists with Saskatchewan Rural Development in Swift Current, Weyburn and Kindersley respectively,
- information contained in an article by Dave Bates in the Country Guide, November, 1988, pages 25-26 (enclosed).

Estimate of the economic value of kochia during the winter feeding period of 1988-89.

1. Swift Current (Peterson)

   About 30% of the 400 cattle producers in the southwest fed kochia.

   . Assume 67 beef cows/herd.

   . Assume 2 tonnes of winter feed/cow.

   . Assume an average of 33% kochia in the diet.

   . Assume a sale value of $50/tonne for kochia.

   The amount fed was:

   0.30 x 4000 x 67 x 2 x 0.3 = 53,060 tonnes

   Value 53,060 x 50 = $2,653,000

2. Weyburn (Klemmer).

   40-50% of the 4300 cattle producers fed kochia.

The amount fed was:

0.45 x 4300 x 67 x 2 x 0.33	= 85,570 tonnes
Value 85,570 x 50	= 4,278,500

3. Kindersley (Piggott)

A significant number of cattle producers (as many as 70%) fed kochia deliberately harvested or as a contaminant is green feed. The amount was not calculated due to lack of reliable estimates.

Total deliberately cut and harvested in the Swift Current and Weyburn areas.	138,630 tonnes
Economic value	$6,931,500
Rounded off to include a low estimate of kochia fed in the Kindersley area	$7,000,000

We believe the two ADF contracts on kochia were very helpful in getting information to farmers about kochia, including a number of articles in 1987 and 1988.

Chapter 1

TECHNICAL REPORT - A SURVEY OF LIVESTOCK PRODUCERS IN SOUTHERN SASKATCHEWAN WHO HAVE UTILIZED KOCHIA FORAGE AS A PORTION OF THEIR WINTER FEEDING PROGRAM - MAINLY TO THEIR WINTERING BRED COW HERD

J. Hanson, Consultant
Moose Jaw, Sask.

1.0 BACKGROUND

During the 1980's serious drought conditions prevailed over much of southern Saskatchewan. Forage crops and pastures were among those hardest hit, being particularly vulnerable to lack of winter snowfall or summer rains. The lack of adequate forage for summer pasture and an adequate forage supply for winter feeding of the basic bred cow herd led to substantial reduction, and, in many cases total dispersal of the livestock herd. The economics of the livestock business was such that farmers could not afford to pay the high cost of forage that had to be brought in from out of province or northern Saskatchewan where transportation costs became prohibitive.

Farmers looked around for alternative feed supply, in addition to the straw which they had baled up after harvest and used as part of the winter feeding program. Many farmers had varying amounts of saline land in their holdings which would not grow cereal crops. This acreage however did grow kochia weed which they had observed cattle would graze when foraging fields in the fall after harvest.

If cattle would eat it they decided they should attempt to harvest it and utilize it as a portion of the winter feed supply. Finding that cattle would eat it when harvested in the early succulent growth stage, its usage became widespread across southern Saskatchewan, especially those areas where soil salinity was widespread and kochia was readily available.

The devastating drought that struck southern Saskatchewan in 1988 caused the failure of most of the spring seeded cereal crops which were written off by crop insurance and farmers were permitted to harvest these for winter feed for their livestock. In many cases cereal stands stressed with drought were also invaded with kochia which flourished under hot dry conditions. The feed that was therefore harvested comprised a good deal of kochia in varying amounts and at various stages of maturity. This situation then became the first introduction many other livestock producers had to the use of kochia in the winter feeding ration.

Research scientists, recognizing that very little was known, regarding the use of kochia as a forage, undertook to carry out research on various aspects of this saline tolerant plant which had spread across the southern plains.

Since there was already considerable usage of kochia by farmers as a supplemental forage the decision was made to collect, through a farm survey, information that farmers could provide who had been involved in harvesting and feeding kochia.

2.0 OBJECTIVES

2.1 To contact livestock producers who had experience in harvesting and feeding kochia to their livestock herd.

2.2 To document information they were able to provide on aspects of production, harvesting and feeding of kochia.

2.3 Where possible to obtain any available information from producers who had experience in pasturing kochia or had utilized it as silage.

2.4 To document any health problems that were suspected to have occurred as a result of feeding kochia.

3.0 METHODS

- A survey questionnaire (a copy of which is included with the report) was developed for use with livestock producers to document their experience and observations in various areas related to kochia production, harvesting and feeding.
- A combination of on farm interviews as well as telephone interviews were used to collect the data.
- A sample group of 100 livestock producers from different geographic areas in southern Saskatchewan, who had and were feeding kochia were interviewed, and their experience and observations formed the data recorded.
- An effort was made to seek out some producers who had encountered problems as well as those who had positive experience in utilizing kochia as a livestock feed.

Livestock producers from the following geographic locations in southern Saskatchewan are represented in the 100 producers comprising the sample drawn for this survey; Briercrest, Mortlach, Yellow Grass, Rosetown, Pambrun, Central Butte, Mossbank, Crane Valley, Cardross, Midale, Moose Jaw, Milestone, Weyburn, Deloraine, Man., Shamrock, Kronau, Ogema, Parry, Lang, Parkbeg, Lafleche, Glentworth, McCord, Assiniboia, Perdue, Mankota, Limerick, Wood Mountain, Fir Mountain, Tribune, Regina, Francis, Tyvan, Ceylon, Zehner, Pangman, Chamberlain, Spring Valley, Avonlea, Ormiston, Chaplin, Courval, Truax, Weyburn, Vonda.

The following is a summary of responses to questions in the survey questionnaire and outlines the experience and observations that farmers have had in the utilization of kochia as a portion of their forage ration.

4.0 RESULTS

4.1 Type of operation

Among farmers interviewed 98% were grain-livestock operations, 2% were ranching only.

Three percent had beef cow herds of 25 head or less; 29% had herds of 25-50 cows; 24% had herd size of 50-75 head; 12% represented cow herds of 75-100 head; 24% had size of 100-200 cows; 6% were over 200 head; 2% were over 300 cow herd size.

Two percent were in dairy production; 9% operated a feeder program to feed out their calf crop and young bulls; 2% were involved with backgrounding their calves; 8% operated a feeder operation custom feeding some cows and young stock as well as managing their own feeder operation.

4.2 Degree of salinity

69% of respondents indicated acreage in excess of 10,000 acres (total on these farms), average of 145 acres that were saline affected to varying degree; 17% indicated that they did not have saline soil growing kochia and that they had harvested kochia off their neighbours saline acreage. The nature of saline ground varied from pot holes and seeps in cultivated fields to low lying land, dry slough areas and large pasture areas, largely native, carrying high load of salts.

4.3 Source of kochia harvested for feed

60% of kochia users had harvested kochia off their own land; 17% had harvested only off neighbours' kochia stands; 20% had obtained kochia from both their own and neighbours land; 3% had harvested kochia off dried up lake bottom (i.e.) Old Wives Lake, Kettlehut Lake.

4.4 Cropping of saline soils

A wide range of crops had been tried on the saline acreage that farmers owned in their land holdings. As a general rule production had been limited, varying with the intensity of the salinity and the weather pattern during the growing season. In the majority of cases kochia had invaded the saline areas and represented the major growth, unless the kochia had been successfully removed by early herbicide spraying. The following represents the cropping patterns undertaken: 20% spring wheat; 26% barley; 16% sweetclover; 9% fall rye; 8%

oats; 3% winter wheat; 5% continuous cropping; 4% grass-alfalfa; 9% cultivation-volunteer kochia.

4.5 Consistency of kochia growth on saline sites

71% of farmers indicated that kochia grew quite consistently on their saline acreage. Of this number 11% indicated that they worked up their saline ground both spring and fall and that kochia volunteered regularly after cultivation. Where salinity was largely limited to pot holes scattered through regular cultivated and seeded fields, kochia grew consistently, probably due to regular cultivation.

29% of farmers responded that they had encountered inconsistent growth from year to year of the kochia they had harvested. This appeared to be an area of frustration to them where they were depending upon harvesting a supply of kochia to supplement their winter forage supply. This also meant that a number of them were harvesting kochia off different neighbours land, as their own or neighbours stands previously harvested had not produced that year.

In some cases no soil disturbance had been undertaken to stimulate kochia growth. Where crop had been seeded and had started well the farmer had chosen to spray out the young kochia stands, and in a number of cases, where low lying land or dry sloughs were involved, the stone problem in them was such that they could not be readily cultivated.

4.6 Kochia usage off saline soil areas

87% of respondents had harvested kochia as hay allowing it to dry in the swath and baling it for winter feed. 7% had cut it green and put it up as silage; 3% had combined patches and worked the residue back into the soil. 3% had swathed kochia patches in the crop and left them to be foraged by the livestock herd grazing cropped land after harvest.

4.7 Control of kochia in crop land

72% reported variable to good control of kochia in their crop land. 28% indicated poor control of kochia in crop stand with considerable variability depending upon the season. The hot dry summer of 1988 meant that many farmers did not spray and were not able to control kochia in their crop land. They expressed concern that infestation in crop land was increasing in spite of herbicide use to control it. There is real fear among some farmers that kochia will invade to a point where they will no longer be able to control it.

4.8 Herbicides used in the control of weeds and kochia in crop land

40% of respondents stated they had used 2-4-D plus Banuel and had achieved satisfactory control of kochia and other weeds on their spring seeded crop. 14% had used 2-4-D only with varying degree of success. 13% had used Glean with good success. 11% had applied Ally, one of the newer chemicals, and reported excellent results with it. 8% had used Buctril M, while 9% had used a range of other newer herbicides on the market. 5% reported that they had not used any herbicidal spray on their crop.

4.9 Use of kochia for grazing purposes

47% of farmers indicated no experience with grazing kochia. 6% had utilized young kochia for one month in the spring as pasture, also kochia with some native grass, and kochia with seeded fall rye. They reported that no illness or death loss was involved.

24% reported having utilized kochia for summer pasture where grazing covered various periods of 1 month to 6 months.

In nearly all cases other material was available besides kochia, such as native grass, slough grass, barley and oat crop written off due to drought. No illness or death loss was reported from this group. 23% had experience with fall pasture grazing of kochia, mainly kochia grazed with other crop residues off stubble fields after harvest. In one situation cattle had been grazing a lake bottom and two animals had died. In another case cows were grazing kochia in the late fall after hard frost with the loss of 4 cows in 1983 and 3 cows in 1984. There does not appear to be a problem where livestock have foraged fields after harvest in the early fall prior to frost. The problem appears in late fall or early winter while cattle are still free to forage, which is often the situation in southern Saskatchewan.

4.10 Occurrence and propagation of kochia stands

94% of farmers in the survey indicated that their kochia stands which they had harvested were natural occurring stands. 6% had seeded their stands. Four of the six had encountered problems in establishing an adequate stand whereas two had obtained good stands of kochia.

83% reported having worked up their kochia producing saline areas and seeded some cereal crop. The percent survival of the planted cereal varied widely dependent upon the weather and degree of salinity involved. In most years kochia took over and represented from 80-100% of the stand at the time of cutting. 17% had not undertaken any cultivation of the areas from which they were harvesting kochia. The response from this group was variable with quite a number indicating continuing good stands of kochia without cultivation. Others, however, reported good stands for 2 or 3 years, with substantial reduction of yield there after. Lighter soils appeared to prolong the production of good stands of kochia.

Barley and wheat were the major crops seeded on saline areas. Oats were used to a lesser extent. Fall rye was used quite frequently and where it survived with the volunteer kochia crop it made a good feed.

20% reported working up their saline areas, some in fall and some in spring, leaving this ground not seeded for volunteer kochia to grow. During the very dry season of 1988 three persons reported that they had not worked their summerfallow land throughout the season but had harvested the kochia crop that had grown to add to their feed base.

During the drought years and especially in 1988 a lot of cereal crops that were written off due to drought were salvaged for livestock feed. For the most part these had been taken over with kochia so that kochia was the major portion of the feed. However some matured grain was a part of this forage which improved its' value for feeding purposes. The high incidence of kochia in crop land in 1988 was primarily a result of very little herbicide spray being used and the hot dry weather favoured development of kochia when the cereal crop no longer offered any competition.

4.11 Characteristics of kochia stands

Obtaining good even dense stands of kochia appears to be a major problem among users. However, a majority have been able to quite consistently harvest uniform dense stands of kochia that have not been coarse or woody. Major reasons offered for obtaining good stands were:

1 - undertaking cultivation of areas from which kochia will be harvested,

2 - kochia is harvested off normal field areas that have been seeded to cereals and there is a reasonable percentage of both kochia and cereal stands,

3 - on soils where the salinity level is moderate.

Unfortunately many saline areas vary greatly in degree of salinity occurring within immediate proximity to one another. This promotes major irregularity in height, density, colour and quality of stand for feed purposes. Stunted, yellow kochia stands with high plant populations are reported to be lower in protein value as well as being unpalatable to livestock. A large percentage of respondents identified lack of uniformity of stand as being of major concern to them.

4.12 Harvesting kochia

66% of farmers were using swathing equipment capable of crimping and crushing kochia forage while 34% were utilizing conventional swathers for harvesting. Drying time until kochia could be safely baled varied greatly, with the crimped forage requiring an average of 3-5 days good drying weather as compared to 1 to 3 weeks for the material cut with conventional swather. The tendency of the uncrimped swath to pack very tightly meant that often the bottom of the swath was still carrying high moisture which lead to some spoilage after baling. In hot weather the top of the swath often dried too much, and much baling was done at night or early morning when some dew was present to retain and preserve leaves in the baling process. As a rule not much spoilage was reported even though some kochia was baled at higher moisture content than would be the case with alfalfa.

85% reported using large round balers for baling purposes as compared to 15% using square bale equipment. There was a noticeable increase in loss of leaves reported by those using square bales compared to the round bales.

Early harvesting of kochia, preferably at the bud stage or early flowering stage, provides a forage that is high in protein and also energy. 22% of respondents had harvested kochia prior to flowering stage, 35% at flowering, 8%

after flowering, 16% when kochia was approaching maturity and 19% had harvested kochia through a range of from flowering to maturity. In 1988 when a good deal of drought stricken crop had been invaded with kochia it was often late before they were able to put it up for feed resulting in kochia that was too mature to make good feed.

The yield of kochia harvested for forage has varied greatly ranging from a low of 1/2 ton per acre to as high as 3 ton per acre. Where cereals had been seeded and made some growth in the saline areas the resulting feed harvested varied in cereal content depending on the weather during the growing season and the severity of the salinity. In general the percentage of kochia was considerably higher than that of cereals. In 1988 however much of the winter forage supply came from normal crop land where cereal crop had been written off by crop insurance and was harvested for feed. Since little or no crop spraying was done the percentage of kochia in the harvested forage was higher than normal but in many cases the combination of some cereal forage and kochia provided a minimum wintering ration.

4.13 Experience in harvesting and feeding kochia

40% of respondents had been involved with harvesting kochia as a supplemental winter feed source for up to two years. 42% had been harvesting and feeding it for 5 years. 12% had been involved with kochia for up to 7 years. 4% had fed it for 10 years while 2% had been using it for up to 20 years.

4.14 Class of livestock receiving kochia as part of the winter feeding ration

94% reported that they had fed kochia to their wintering bred cow herd. 14% also indicated they had fed it to their spring calves which were being wintered over. 10% of replacement heifers and yearlings were also receiving kochia. 7% were using kochia in the ration to feeder cattle, while 3% were also feeding it to bulls. 2% reported having fed it to dairy cows, generally in the form of silage. Younger class of animals were generally receiving less kochia in their ration than that being fed to the cow herd.

4.15 Composition of daily feeding ration

19% reported feeding kochia at 25% or less of the daily ration. 33% had fed it at a level of 35% or less. 32% reported feeding it at around 50%, some being over and some under the 50% level. 12% had fed kochia at the 60-70% level while 4% had fed it at 90-100% of the daily ration. Feeding of high levels mainly occurred in the winter of '88-'89 when other forage was in very short supply. In most cases where kochia was fed at high levels it was harvested in 1988 off crop land where grain forage and mature grain existed to a lesser extent along with the kochia. Where the kochia was too mature a good deal of it was left by livestock when it was offered on a free choice basis.

In addition to kochia one or more of the following feed items had been a part of the daily ration being fed: 7% had utilized sweetclover hay; 5% fed silage; 18% used baled cereal forage at grain stage; 81% fed straw both as a feed and bedding; 37% fed slough hay; 31% used alfalfa and tame hay; 4% utilized alfalfa pellets; 20% fed either grain or screening pellets; 68% fed grain, mostly barley or oats; 6% fed chaff; 2% utilized supplement in the form of lick tank and a further 2% indicated extra feeding of minerals.

Of interest is the fact that 88% of producers had included either grain or pellets in the daily ration, although in a number of cases grain was only fed in bunks or on the ground during the cold portion of the winter and prior to calving time.

4.16 Feeding methods

The majority (65%) of the producers were feeding their wintering livestock on a free choice basis. Large round bales, which represented the bulk of the forage, was fed either in round bale feeders or rolled out on the ground. A few producers reported having switched to rolling out bales as opposed to using round bale feeders. Where the kochia tended to be stemmy, they were encountering eye and facial injury from livestock encountering sharp ends of kochia stalks in the round bale feeders.

28% were processing their daily feed ration either through a mix mill or tub grinder. Grain was incorporated in the ration with other ingredients which tended to provide a more accurate intake of ration constituents. Where kochia had been harvested at a mature stage, processing tended to break stalks up into slivers that created sore mouths, lumps and abscess in some of the herd.

The 5% who were feeding chaff as part of the wintering ration were doing so with electric wire. 2% reported hand feeding calves, replacement heifers and bulls on a better quality ration than the cow herd was on. Others however were feeding the same ration to young and mature stock alike.

4.17 Acceptability of kochia by livestock

80% of kochia users reported that their livestock had accepted kochia forage quite well. 20% however, were experiencing some problems with palatability. Kochia harvested at the mature stage, when it was coarse and stalky, meant that it was picked through and a lot of it left. Those who had harvested stands of stunted yellow kochia reported cattle found it bitter and did not prefer it. There appears to be no problem with acceptability where kochia is harvested early in bud to blossom stage and is accepted by some cows in preference to other feed. Palatability is also increased where kochia is processed and fed with other feed as a mixed ration.

4.18 Digestive problems related to feeding of kochia

56% of producers feeding kochia reported that their herd was normal in terms of stools passed when on kochia. 44% however, did comment that their animals were slightly loose to loose, probably where the higher levels of kochia were being fed. There was only one report of a condition approaching diarrhea. Some producers indicated that their water supply was high in salts, which probably added to the laxative condition. One producer noted that his cattle were urinating heavier than usual when on a kochia diet. Grazing kochia as pasture appeared to have a decided laxative effect on the cattle.

75% reported that they had maintained body weight in the cow herd on the wintering ration which included varying percentages of kochia forage.

16% reported weight loss during winter feeding while 9% reported weight gains in their livestock herd.

4.19 Livestock losses

7 cows from four herds were reported having died where too high levels of kochia were suspected as the cause. 5 cows, 3 heifers and one bull were lost where pneumonia, hardware disease and black leg were suspected causes. One cow died and another went blind where late fall grazing was involved. The majority of death losses reported occurred in the fall of '88 and the winter of '88-'89 which was bitterly cold through part of the winter. Cattle went into winter in a stressed condition as a result of lack of adequate pasture due to the summer drought. There were also reports of frozen ears, tails and feet during the winter, due in part to poor circulation and thiamin deficiency. Injections of vitamins and some other items corrected some of the problems.

4.20 Calving performance

92% of respondents reported normal calving where cows had been fed a winter ration that included a varying percentage of kochia. Calves were healthy, strong calves at birth with a number of producers commenting that the cows were yielding good milk supply more than the calves were able to handle.

8% reported calving problems of various kinds. These were mainly in the spring of 1989 after a cold winter, with cow herds in many cases being on less than adequate feed rations during the winter. This was following the summer of drought in 1988 when pastures were also inadequate. Two producers reported dead birth of calves along with some abortions. Two others reported weak calves with cows that were down and a higher number than normal of calves that required to be pulled. Other causes listed were losses due to early calving in extremely cold weather, calves lost due to vitamin deficiency and some lost due to feeding of sweetclover.

4.21 Feed analysis of kochia samples.

22 producers reported that they had a feed analysis carried out on the kochia they were feeding. Protein level ranged from a low of 8% to a high of 18%. The majority ranged from 11 to 14% protein. Only a few recalled energy levels (T.D.N.) from the feed test report. The average of these was 52% T.D.N. What was significant was that at least three of the laboratory reports warned of high nitrate levels in the feed with a caution as to the level of feeding.

4.22 Kochia harvested and fed as silage

7 producers interviewed in the sample reported having put up and fed kochia as silage. Two were dairy producers who had limit-fed kochia silage at

about 1/3 of the ration along with hay, baled grain forage, straw and grain at a higher level needed to support milk production. In neither case were any problems reported and farmers indicated they would continue to use kochia as silage at the same level in their operation.

Two producers had put up bagged kochia silage. One producer reported no problems either in harvesting, bagging or feeding bagged silage. The second producer had encountered a lot of punctures in the bagged silage resulting in spoilage. Undoubtedly the kochia had been harvested too late when it was already in the coarse and woody stage, which contributed to the puncturing problems.

Two operations were feed lots, one doing custom feeding where the kochia silage input was limited to 5% of the ration. No problems were encountered.

The other feeder had salvaged cereal crop in 1988 as silage. It comprised about 70% kochia and 30% grain forage. In addition, substantial amounts of barley were also being fed, both to feeder cows and calves put on feed. His experience was not good. He failed to achieve growth rates and expected weight gains both in the feeder cows and calves. In addition he had a lot of illness and some death loss in both cows and calves.

One producer had fed corn-kochia silage at 25% of the ration along with hay, straw and grain to calves and the cow herd. As an experienced feeder he has used kochia as a portion of the feeding ration for some years without problems.

4.23 The use of kochia as a portion of future winter feeding rations

96% of respondents indicated that they would use kochia forage in the future in their winter feeding program. Within this group 27% gave a definite yes response to future use of kochia, 54% indicated yes with some reservations primarily concerned about availability. 15% indicated they would utilize it as an alternate feed source when other forage material was not available, such as in the drought of 1988.

4% had encountered problems with it and indicated that they would not utilize it again as a fodder alternative. A number of producers voiced concern about the inconsistency of good uniform stands of kochia and the failure of kochia to produce stands that could be harvested year after year. Where they were depending upon kochia as a portion of the winter feed supply the uncertainty of a good quality supply to harvest was the major concern raised about its use.

4.24 Livestock producers suggestions for improvement of kochia as a forage crop

- need to develop lines of kochia that are leafier and with less tendency to develop heavy stems,
- develop lines that have lower levels of toxic compounds (i.e.,) oxalates, alkaloids etc.,
- research the possible use of kochia seed as a further feed source,

- investigate methods of maintaining quality in carryover kochia (i.e., kochia hay stored for one or more years) where attempts were made to build some feed reserves,
- need to research the use of kochia for pasture purposes,
- investigate kochia's role as forage when put up as silage,
- need to determine reasons for the tremendous variability that exists within stands of kochia, (i.e., normal growth stands vs. short yellow stunted stands),
- need to determine reasons for kochia stands dying out and for the variability in quantity and quality of stand from one year to the next,
- carry out feeding trials to determine its suitability and level for feeding as a ration component to various classes of livestock,
- determine the suitability of using forage preservatives when baling kochia due to its slow drying characteristics,
- investigate its potential as a mixed forage crop grown with other salt tolerant forage,
- determine its ability to improve production potential of saline soils,
- research its potential for sufficient soil improvement to permit establishment of permanent grass-legume cover on saline soils.

4.25 Livestock producers attitude toward further research on kochia

With the exception of a few producers in the survey, nearly all respondents were positive in supporting more research on kochia. After the serious drought in 1988, when many cattlemen had to rely on kochia forage and straw for their wintering herd or consider herd dispersal, they have realized how important kochia stands can be in emergency situations.

5.0 COMMENTS AND OBSERVATIONS VOICED BY PRODUCERS REGARDING KOCHIA

- many producers expressed concern regarding the continuing spread of soil salinity.
- They recognize that kochia has been a valuable feed crop they have been able to harvest off saline acreage that will not produce cereals.
- Many livestock herds were saved from market in 1988 when cereal forage and kochia was the only available feed.
- A number of farmers reported soil improvement of their saline acreage after harvesting kochia for some years.
- Wintering feed costs have been reduced using kochia and sweetclover, grown on saline land, and chaff as part of a winter feeding ration.
- Many who harvested kochia when it was mature realize the need to harvest early to get a palatable and quality product.
- There is a need for greater cooperation between the straight grain producer with saline acreage and his neighbour with livestock to utilize marginal saline acreage and to utilize volunteer kochia as feed before seed is scattered over more land area.

- Although kochia is not a major problem as yet in non-saline cropland concern is evident that it could develop resistance to herbicides and become a serious weed problem in crop land.
- Producers have realized that utilizing kochia as part of the ration provides considerable savings in feed costs.

6.0 CONCLUSIONS

- The harvesting and feeding of kochia as a portion of the winter feeding ration by livestock producers across southern Saskatchewan is widely practised, and yearly harvesting of kochia stands for feed is an established routine among many producers.
- Many kochia users were first introduced to kochia as a potential forage in the severe drought of 1988 when normal forage supplies were not available. Drought stricken crops invaded with kochia due to lack of spring spraying, and written off by crop insurance became the feed source of fodder for winter feeding.
- Cattlemen have continued to harvested kochia both in unmixed stands off saline areas and from crop land severely infested with kochia but yielding a percentage of cereal grain or hay.
- In 1988 a few people reported that they had not worked summerfallow through the season. A good stand of volunteer kochia developed which they harvested for feed. This practice could provide a source of more fodder in a drought emergency year such as 1988.

- There is little doubt but that kochia kept many in the livestock business through '88-'89 avoiding further depletion of cattle herds in southern Saskatchewan.
- Farmers recognize that utilizing kochia, and crop residues such as chaff can provide help to substantially reduce their winter feed costs.
- Much of the kochia which has been fed has been harvested too late when it is already coarse and woody and not readily accepted by livestock. Early harvesting at bud to blossom stage provides a fodder usually high in protein with good energy (T.D.N.) level as well as being quite palatable.
- The use of fall rye and winter wheat seeded into tolerable saline areas can yield a forage with a percent of cereal grain to raise the energy level of the resulting forage.
- There is evidence to suggest that kochia is not a suitable feed to include in a ration being fed to calves or other growing stock unless it represents a small amount in the ration. It appears that mature animals are best able to handle it, at levels preferably under but not over 50% of the ration, and where other sources of fodder such as hay and straw, along with some grain, constitute the balance of daily intake.
- Harvesting kochia at the optimum stage requires a swather with crimping equipment to facilitate drying of the swath in reasonable time. Kochia harvested with an ordinary swather requires a long

drying period when the quality of the kochia can deteriorate if subjected to much rain.

- Producers report baling kochia at night or early morning when it is slightly tough to retain maximum leaves. Large round bales are the preferred method of baling, saving a maximum of leaves and with standing weathering in open storage.
- There is need for more information to farmers regarding the toxic properties associated with kochia and the need therefore to indicate maximum safe levels for feeding kochia. It appears that a range of between 1/3 to under 1/2 of the fodder input can be fed as kochia to mature wintering cattle.
- The majority of problems that producers encountered developed during feeding in the winter of '88-'89. Because of feed shortage and lack of grain the percent of kochia fed in the daily ration rose to 70% and higher as reported from a number of producers. This was the group who encountered problems with cattle going off feed, various illness, some abortions and dead calves. In some cases where other feed and grain was introduced and the kochia content of the ration was reduced to 40% or less, problems cleared up.
- It appears that where kochia content of ration was kept to under 50% cows calved out strong vigorous calves with no more than normal calving problems.

- Producers are concerned about the variability in stands of kochia and the lack of consistent production over a period of years. This poses a problem where the feeding plans include a percent of kochia in the feeding ration on an ongoing basis.
- There appears to be a real opportunity for much closer cooperation between the farmer in straight grain production with saline land that is providing no useful production and the livestock farmer who can utilize kochia as feed off these saline areas. It would possibly require some early planning as these saline areas need cultivation to promote volunteer kochia growth and arrangement to access and harvest the kochia at the optimum stage.
- Producers are interested in the potential use of kochia for pasture purposes. A few producers have tried grazing kochia, mostly with access to other forage or grain. There is need to further research this area.
- Although the majority of farmers will likely harvest and feed kochia in cured hay form, dictated largely by the equipment presently available, there are some farmers who see harvesting kochia in silage form as offering advantages over other harvesting methods. There is need for research and more information, especially the feeding aspect of kochia as silage.
- Livestock producers who are harvesting and feeding kochia need to be encouraged to make greater use of the Saskatchewan Feed Testing

Laboratory at Saskatoon to obtain information on protein and energy levels and to know if nitrate levels are in a safe range for normal feeding. Where kochia has been taken from slough bottoms that were dry, feed test results have indicated high nitrate levels sufficient to warrant restricted feeding of the kochia component. It is also possible to arrange either with the Feed Testing Laboratory or the regional livestock specialist for assistance in formulating an adequate daily ration involving kochia and other forage and grain items available.

7.0 IMPACT ON SASKATCHEWAN AGRICULTURE

The use of kochia as an alternative source of fodder in the severe drought year 1988 saved an untold number of livestock herds in southern Saskatchewan. It was harvested off saline flats and crop land devastated by drought and invaded with kochia. When hay and straw were not available it did provide a source of roughage and unknown numbers of farmers harvested it for a winter fodder supply. From the survey taken of 100 livestock producers it became evident that a lot of farmers had been harvesting and feeding kochia for some years. One producer reported using it for 20 years. Many more were introduced to it in 1988 and have continued usage since then. There was positive response from farmers when asked if research should be continued on kochia. The reasons given were the present and growing acreage of saline soil and the fact that it was a cheap feed source off a land base that would grow no other productive crop. One livestock producer stated that he had saved in excess of

$3000 on his feed bill by utilizing kochia as part of the winter feed ration. This is but one example where substantial savings have been made on feed costs and no doubt applies equally to many more producers over southern Saskatchewan.

The use of kochia is well established among many producers and will continue to grow as more farmers learn to harvest and feed it.

Chapter 2

QUESTIONNAIRE SURVEY TO PRACTISING SASKATCHEWAN VETERINARIANS. THEIR EXPERIENCES AND OBSERVATIONS WITH WINTERING LIVESTOCK HERDS WHERE THE FORAGE RATION FED HAD CONSISTED OF VARYING PERCENTAGES OF KOCHIA AS PART OF THE TOTAL FORAGE INTAKE

1.0 INTRODUCTION

- During the 1980's drought conditions existed through a number of years in southern Saskatchewan. Native and tame forage crops which normally supplied winter feed to livestock herds failed or produced greatly reduced yields. The year of 1988 was particularly severe, with little or no grass forage or pasture produced that year. The severity of the drought also resulted in failure of much of the cereal seeded crop, and farmers turned to harvesting this crop, which had been invaded with considerable kochia, for winter feed for their livestock. In most cases there was little grain in the crop and the kochia was too mature to make good feed when it was harvested. The percentage of kochia tended to be high in the crop stand. In addition farmers harvested pure stands of kochia off saline acreage as kochia was about the only crop growing on this type of soil. They chose to use it also for livestock winter feed.

The summer of 88 was hot and dry. The majority of pastures were in fair to poor condition and in many cases cattle were turned into crop stands to graze, as no meaningful grain crop would be harvested off them. Cattle generally were only in fair to poor condition entering the fairly severe and cold winter of '88-'89.

- Recognizing that there were certain toxic compounds within the kochia plant which if fed at high levels could create problems and knowing that this feed source had represented various levels of the ration fed, veterinarians would be the likely people to have dealt with problems if they arose. Thus they were surveyed to find out what feeding problems they had encountered which might be due to kochia in the cattle or calf diets.

2.0 MATERIALS AND METHODS

A survey questionnaire (enclosed as an Appendix) was sent to veterinarians, plus a follow-up letter, to obtain information on problems with kochia. Results were analyzed for trends and associations.

3.0 RESULTS

The following represents responses obtained from veterinarians who participated in the survey:

- A total of 64 veterinarians in the province were included in the survey.
- Of this number, responses were received from 49.
- Of the 49, only 21 were practising in areas of southern Saskatchewan where they had been involved with farmers feeding kochia.
- It became evident that the bulk of kochia harvested and fed had been south of the QuAppelle Valley System stretching across southern Saskatchewan and in the open plains area where soil salinity was a

problem, such as areas around Last Mountain Lake, and other scattered saline areas. There appeared to have been very little usage of kochia in the park belt area, in part due to availability of other feed, and in part to lack of widespread penetration of kochia into these areas.

- The survey pertained mainly to winter feeding of beef cattle. The questions are listed with a summary of responses.

1. Have you serviced livestock herds where kochia formed a portion of the forage ration? Yes _21_ No _28_
2. What percentage of herds that fed kochia would be represented in the following levels of kochia in the diet (25% or less - average 59%) (50% or less - average 34%) (75% or less - average 7%).
3. What class of animals were being fed kochia? (Spring calf crop - 7%) (yearlings - 19%) (bred beef cow herd - 74%)
4. What other items would have been a part of the feeding ration? Straw - 31%; hay - 29%; grain - 30%; chaff - 10%.
5. How was the kochia put up and fed? (large round bales - 53%); (square bales - 21%); processed with other feed - 23%); (silage - 3%).
6. At what stage had the kochia been harvested for feed? Over mature and coarse (50%); fine stemmed and leafy (34%); unknown (16%).

7. Had there been considerable spoilage (mould and mildew) in the bales? Considerable spoilage (14%); no spoilage (67%); minimum spoilage (19%).

8. To what degree if any did you encounter illness that you might attribute to kochia feeding?

   No illness - 30%; illness in 2% of animals (20%); illness in 5% of animals (25%); illness in 10% of animal (10%); uncertainty re likely cause of illness (15%).

9. Did you encounter death loss which might be attributed to kochia feeding? None (52%); 1% loss (10%); 2% loss (5%); 5% loss (9%); 10% loss (5%); unknown (19%).

   Note: - These losses largely occurred during the winter of '88-'89 which was severely cold for a portion of the winter with livestock coming into winter only in fair to poor condition following a dry, hot summer when pastures were very poor.

10. What would be your assessment of the calf crop from cows that had been wintered on a ration were kochia was fed at varying levels. - no difference - normal calving (71%); abortions - 10%; no knowledge (19%).

11. Where death loss had occurred was a laboratory diagnosis undertaken? Yes - in 6 cases; No - in 3 cases.

12. What did the lab diagnosis indicated?

    Polioencephalomalacia (3 cases); pre-mortem serology + C.B.C's;

Hepatotoxicity; renal damage; no evidence of infection; low blood calcium; intestinal irritation; loose feces.

13. From your observations of herds wintering on a kochia ration have you observed serious problems that have arisen that might be due to the kochia constituent in the ration?

    - Comments: protein imbalance in total ration; high oxalates in kochia; hypocalcemia; sore mouths; allergic pneumonia; mineral depreciation; diarrhea; lack of palatability; vasoconstriction; freezing of extremities: ears, tail, feet; blindness; milk fever.

14. Other comments relating to your experience with kochia as a livestock feed source.

    - Comments: over 25% kochia in the ration where sulphates are high in the water source causes diarrhea; late harvesting of kochia greatly reduces palatability; feeding at a low level with wheat straw will overcome scouring; should comprise only about 25% of ration; farmers forced to feed kochia at higher levels in '88-'89 winter due to lack of other feed source.

Note: 50% of the veterinarians who responded where they had contact with herds where kochia was being fed reported no problems. Problems generally were in herds where kochia was being fed at high levels (over 50%) with little other quality roughage and little or no grain.

15. Have you encountered any problems where livestock were summer or fall grazing kochia and if so what problems were evident?

- Majority of veterinarians responding had not had experience with cattle grazing kochia as pasture. Two had observed a condition of diarrhea when cattle were grazing kochia. One veterinarian had attended where 2 cows had died from overload on a lush kochia stand.

16. We are aware that some farmers are putting up and feeding kochia as silage, either straight kochia or kochia and cereal crop. Have you encountered this situation or any problems from it?

- only 5 veterinarians had experience with kochia silage being fed as a part of the ration. 5 producers had fed it at low levels with no problems. In one case kochia and Russian thistle were being fed as silage to calves. There were problems with polioencephalomalacia. Injections of thiamine had corrected the problem. Poor gains were also reported where kochia was fed in a feed lot situation.

Note: Coupled with a dry summer and very poor pasture grazing plus the stress of a cold winter in '88-'89, feed supplies that winter were generally below normal in quality and quantity. They often comprised drought stressed cereal crop written off by crop insurance carrying a high incidence of kochia in it.

943 Simcoe Street
Moose Jaw, Saskatchewan
S6H 3J1
September, 1989

To: Veterinarians practicing in Saskatchewan:

Could I ask for a few moments of your time to complete the enclosed questionnaire. The information from it will supplement other data that is being gathered from livestock producers who have been involved in feeding Kochia as a source of fodder for winter feed. This will form a part of research on Kochia that is being carried out by the Saskatchewan Research Council, Saskatoon, Agriculture Canada, Swift Current Research Station and the University of Saskatchewan. It is being funded through the Agricultural Development Fund with a report to be prepared at the conclusion of the project.

During past winters and especially the winter of 1988-89 in particular, farmers in southern Saskatchewan harvested and fed Kochia to their wintering livestock herds because little other forage was available other than very expensive supplies from outside of the province or within the province where transportation costs became prohibitive. In some cases the ration fed was almost totally Kochia ranging down to percentages below 50% which has been the recommended level for feeding.

We have had some reports of problems where high levels of Kochia were fed and we are particularly interested in your experience and observations regarding this matter.

We are enclosing a questionnaire which we hope will cover the information we would like to gather but would invite any further details or comments you might wish to make.

Thanking you in advance for your co-operation.

Yours sincerely,

J. Hanson

John Hanson, Ag. Rep. (Retired)
Co-ordinator-Survey project

943 Simcoe St.
Moose Jaw, Sask. S6H3JI
November 3, 1989.

Some time ago I mailed out to veterinarians in the province a survey questionnaire regarding their experiences with livestock producers where kochia had been fed as a substantial portion of the forage ration.

I have had good response to this survey but would like to obtain as complete a picture of this situation as possible.

Could you take a few moments to complete and return the enclosed questionnaire and return it in the enclosed stamped and addressed envelope .

Thank you for your cooperation,

Yours Sincerely,

John Hanson

QUESTIONNAIRE - VETERINARIAN SURVEY

This survey pertains mainly to winter feeding of beef cattle.

1. Have you serviced livestock herds where Kochia formed a portion of the forage ration?

_______(yes)   _________(no)

2. What number of herds that fed Kochia would be represented in the following levels of Kochia in the diet?

______(25% or less)   _______(50% or less)   ______75% or less)

______(up to 100%)

3, What class of animals were being fed Kochia?

_______(wintering spring calf crop)   _________(yearling plus steers & heifers)

___________(wintering bred beef cow herd)   __________(dairy cows)

4. What other items would have been a part of the feeding ration?

_______(straw)   _______(slough hay)   ______(grain - oats & barley)

_______(chaff)

5. How was the Kochia put up and fed?   _________(large round bales)

_________(square bales)   ________processed with other feed through mix mill or tub grinder.

6. At what stage had the Kochia been harvested for feed?

_______(over mature & coarse)   _______(fine stemmed & leafy)

7. Had there been considerable spoilage (Mold & mildew) in the bales?

________(yes)   __________(no)

8. To what degree if any did you encounter illness that you might attribute to Kochia feeding?

___________(%)

9. Did you encounter death loss which might be attributed to Kochia

feeding?   ________(%)

0. What would be your assessment of the calf crop from cows that had been wintered on a ration comprising Kochia?

____

____

11. Where death loss had occurred was a laboratory diagnosis undertaken?

________(yes) __________(no)

12. What did the lab diagnosis indicate?__________________________

____

____

13. From your observations of herds wintered on a Kochia ration have you observed serious problems that have arisen that might be due to the Kochia constituent in the ration?

____

____

14. Other comments relating to your experience with Kochia as a livestock

feed source:____

____

____

15. Have you encountered any problems where livestock were summer or fall grazing Kochia and if so what problems were evident?

____

____

16. We are aware that some farmers are putting up and feeding Kochia as silage, either straight Kochia or Kochia and cereal crop. Have you encountered this situation or any problems from it?

____

____

NAME:________________________ TELEPHONE NUMBER_______________

ADDRESS:____ POSTAL CODE____________

Chapter 3

EFFECTS OF SEED SIZE SELECTION OR SEED CALYX REMOVAL ON KOCHIA FORAGE YIELD AND FEED VALUE

E. Coxworth and A. Mair.

1.0 INTRODUCTION

Kochia seed as harvested by the combine is enclosed in a papery, five pointed calyx. There is a pericarp (outer layer) on the seed itself which is fairly easily removed by rubbing. Abouguendia (1988) found that removal of the calyx (by rubbing) increased the extent of germination of the seed, particularly when the seed was germinated in a saline environment. In a similar study we found (Coxworth et al., 1988a) that removal of most of the pericarp gave more complete germination (Table 1).

Kochia seed varies greatly in seed size. We found in an earlier study (Coxworth et al., 1988b) that large seed germinated more completely than small seed (Table 1).

Table 1. Percent germination comparison (in 48 hours) of two sources of kochia seed, four seed sizes, with or without pericarp.

Seed Size based on mesh size	Texas (Nieto)		Saskatchewan (Marin)	
	Pericarp coated	Uncoated	Pericarp coated	Uncoated
>16	93	100*	69	97
>18	90	97	77	91
>20	81	93	60	77
>30	56	69	24	34

* Germination complete in 8 hours.

Furthermore, large seed could be planted deeper than small seed, and gave larger seedings after 21 days (Table 2).

Table 2. Effect of seed size and planting depth on fresh weight of kochia seedlings after 21 days.

Seeding depth		Seed size	Fresh weight (g)
(mm)	(inches)		
6	0.24	Small	2.15^{b}
10	0.39	Small	2.18^{b}
15	0.59	Small	1.58^{a}
6	0.24	Large	2.64^{b}
10	0.39	Large	3.21^{c}
15	0.59	Large	2.53^{b}

Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

These studies indicated that removal of the papery calyx and most of the pericarp improved germination of kochia. It remained to evaluate whether removal of the calyx and pericarp would affect final forage yield or forage feed value. In similar fashion, these earlier studies indicated that selection for large seed size improved germination and emergence from deeper planting depths. Would the selection for large seed size have any effect on final forage yield or on forage feed value?

The experiment described in this chapter was designed to test the effects of seed size or calyx removal on kochia forage yield and feed value. Large pots were prepared with a uniform soil mixture, and these pots were set in the ground outside to measure kochia forage yield and forage feed value. The soil was not saline so as to avoid the complication of the introduction of a further variable in the experiment. The pots were watered so that the kochia grew without any restrictions due to lack of water.

2.0 MATERIALS AND METHODS

A mixture of five parts soil, one part sand, and one part vermiculite was prepared at 50% field capacity in 607 cm^2 surface area (16 litre volume) planting pails. At 6.5 cm below the soil surface, 11-51-0 fertilizer was added at a rate of 45 kg P_2O_5/ha (0.536 g/pot) and urea was added to make up to 100 kg N/ha (0.945 g/pot).

Twenty pots were prepared a consisted of four replicates of small, medium and large seed size, calyx on and calyx off (medium seed size), 6 plants/pot equalling abut 99 plants/m^2. The seed were a limited seed shattering selection from one kochia plant grown in Saskatoon, Saskatchewan and were approximately 0.9 g/1000 seeds.

For seed size selection, three Canadian Standard Tyler sieves were used. For seed size effect studies, kochia seed, as harvested, was rubbed with a large rubber stopper, when placed on Tyler screens of #12, #14 and #16 size, to remove the calyx and most of the pericarp. Treated seed was separated into different seed sizes by rescreening on #14, 16, 18 and 20 Tyler screens. Small sized seeds were retained on #20 mesh (0.85 mm), medium seeds were 18 mesh (1.0 mm), and large seeds were 16 mesh (1.18 mm). For calyx removal, the chosen seeds were divided in half and one half was gently rubbed with a large rubber stopper to remove the calyx and some of the pericarp while the other half was planted with the calyx and pericarp on.

The seed for all treatments was planted at a depth of 10 mm, which an earlier trial had established as giving good seedling emergence and early growth (Table 2).

On June 23, the pots were set outside and sunk in to the ground, level with the soil surface. Pots were arranged with all treatments in a randomized design in five rows. The plants were watered daily to 50% field capacity and heights measured weekly. The plants were harvested at 54 days of growth, in the flower stage (August 16).

Wet weights were recorded, then the plants were dried in a forced air drying oven at 30°C for 3 days and the dry weights were measured. The samples were then ground for analysis.

3.0 RESULTS AND DISCUSSION

Seed size had no significant effect on the kochia establishment or yield (Table 3), but there was a significant effect on yield when the calyx was removed (Table 4). There was a highly significant effect on percent crude protein when the calyx was removed from the seed, but no effect on digestibility of the forage with any of the treatments (Table 5.).

Table 3. Effect of kochia seed size on germination height and yield of forage.

Treatment	Germination (%)	Mean Height at Harvest (cm)	Mean Yield ((g/pot)	Mean Yield (g/m_2)
Small seed	34	49.5	43.5	722.8
Medium seed	59	51.2	41.1	682.6
Large seed	43	55.5	46.2	766.6
Significance of effect	NS	**	NS	NS

NS = no significance
** highly significant ($p>0.01$)

Significance of effect is according to a one-way ANOVA statistical test ($p>0.05$).

Table 4. Effect of kochia seed with calyx on versus calyx off on germination, height and yield of forage.

Treatment	Germination (%)	Mean Height at Harvest (cm)	Mean Yield (g/pot)	Mean Yield (g/m_2)
Calyx on	61.0	47.8	47.5	788.6
Calyx off	55.08	55.8	62.4	1036.6
Significance of effect	NS	**	**	**

NS = no significance
** highly significant ($p>0.01$)

Significance of effect is according to one-way ANOVA statistical test ($p>0.05$).

Table 5. Effect of seed size and calyx removal on digestibility and crude protein of kochia forage.

Treatment	CP	OM	IVOMD
	%		
Small seed	10.6^a	88.2	56.3
Medium seed	10.2^a	88.7	56.3
Large seed	11.7^a	87.9	57.2
Calyx on	12.6^a	87.5	58.7
Calyx off	15.0^b	87.2	56.4
Significance of effect	**	NS	NS

NS = no significance.
** highly significant ($p>0.01$).

Means within column with the same superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$).

4.0 CONCLUSIONS

Seed size selection did not have an effect on kochia forage yield or feed value. However, it did have an effect on the emergence of seed from deeper planting depths, which could be an advantage in some planting situations.

Removal of the calyx and some of the pericarp had a significant effect on increasing forage yield, and on increasing forage protein content. The experiment should be repeated several times with different seed sources to confirm that this interesting and potentially useful effect is consistently observed. If the effect is confirmed, then this simple seed treatment could be used to improve forage yield and quality.

The best time to repeat this study would be after selected lines of kochia have been produced. Considerable progress has been made in the last two years at the Swift Current research Station of Agriculture Canada (Knipfel and Green, 1990). Uniform selections of improved forage appearance (e.g., leafiness) have been obtained. Once the best of these selected lines have been obtained, then the seed from these lines should be treated to remove the calyx and the pericarp to determine whether this seed treatment will improve forage yield and feed quality.

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Chapter 4

A. EFFECT OF PLANTING DENSITY OF KOCHIA ON STEM DIAMETER AND FORAGE YIELD

E. Coxworth and P. Kullman

1.0 INTRODUCTION

The results of a survey of farmers in Saskatchewan who had harvested and used kochia (Hanson, 1988) indicated that the coarse, woody stems of kochia plants were a source of problems in that they were hard to cut, made plants harder to bale, and were rejected by animals consuming the hay. Farmers frequently used tub grinders to chop the large stems to improve the intake of the hay.

Studies in New Mexico by Fuehring (1984) demonstrated that kochia could be grown at a wide range of planting densities (up to 1540 plants/m^2) without negatively affecting forage yield. In irrigated trials of Texas kochia in the Outlook area of Saskatchewan in 1987, Derdall (1988) found good yields of kochia at planting densities of over 400 plants/m^2 and observed that the stems were slender (e.g. less than 1.3 cm diameter) and were palatable to cattle.

The experiment described herein was designed to grow kochia at a variety of planting densities in large plastic containers (approximately 14 litres) in the field. The plants were grown with high soil fertility (non-saline) and frequent watering so that neither fertility nor moisture restricted growth. The plants were harvested at a mid flower forage stage. The yield of forage, the number of plants, and the average stem diameter were measured to test the effects of planting density on forage yield, stem diameter, and forage quality.

2.0 MATERIALS AND METHODS

Kochia seed was obtained from one mature plant found east of the Western College of Veterinary Medicine in the late winter of 1987-88. The plant had shed very little seed even though it was physiologically mature. The calyx was infolded rather than expanded in the normal five pointed fashion considered characteristic of kochia (Kochia Scoparia L. Schrad). It was hypothesized that the infolded calyxes would make the fruits less likely to be blown off the plants by wind. If this trait was inherited it would be a useful property for a domestic kochia forage variety, i.e., less tendency for the seed to be blown off the plant and scattered.

A soil mix consisting of two parts sandy loam (Dressler Landscaping, Saskatoon, Sask.) and one part builders sand, was used. Three gallon plastic pails (surface area $0.0613m^2$ per pail) were filled with the soil mix. Urea and 11-51-0 were placed in a layer on the soil surface to provide the equivalent of 100 kg N/ha and 50 kg P_2O_5/ha. Further soil was placed on top of the fertilizer to cover the fertilizer to a depth of 2.5 cm. Kochia seed at three rates: 10 seeds, 20 seeds, and 30 seeds per pot, was seeded at a depth of 0.5 cm. Each treatment was replicated four times.

The soil had previously been moistened to 70% of field capacity. Only the surface of the soil was carefully watered to initiate germination.

The pails were drilled with several 1 cm diameter holes at the base to ensure drainage (prior to being filled with soil).

The pails were placed in trenches at the 115th Street research site of the Saskatchewan Research Council. The soil was filled in around the pails. A covering of light spun-bonded fiberglass blanket (Reemay) was placed over the pails and held in place by stones.

The kochia was seeded on June 29th, 1988. Pots were watered every day, and then every other day as the plants grew. The polyester blanket was removed by the time the kochia seedlings were approximately 3-5 cm high, and had developed at least several pairs of true leaves.

Pots were watered to restore them to 70% field capacity. To establish the amount of water to add, three control pots were placed inside three other empty pots sunk to the lip in soil. The control pots were also planted with kochia.

All pots were treated with a fertilizer nutrient solution equivalent to adding 50 kg N/ha and 25 kg P_2O_5/ha, on 29 August.

The plants were harvested (at ground level) on 6th September 1989 when the plants were at the early to mid fruiting stage (plants still green). The number of plants per pot, plant weight per pot (after air drying two days at 30-35°C in a forced air oven), and average stem diameter per pot, were measured.

After air drying the plants (per pot) were separated into leaves and stems.

3.0 RESULTS

The pots were planted to kochia very late in the season. The season itself was very hot and dry (drought of 1988). It was very difficult to keep the soil surface moist. Germination and emergence were very low and it was not possible to obtain the 7, 14 and 21 plants per pot originally intended. Plant numbers per pot ranged from 2 to 14. The experiment was continued as a completely randomized design.

The number of plants per pot and the relationship to stem diameter and weight of plants per pot are shown in Table 1.

Table 1. Relationship of plant density to stem diameter, plant yield and percentage of stems.

# Plants /pot	/m^2	Stem diameter (cm)	Plant yield g/pot	Stems as a percentage of whole plants
1	16	1.00	55.9	47.8
2	33	1.00	149.2	46.0
3	49	0.75	110.2	43.0
3	49	0.70	104.2	40.8
4	65	0.90	137.6	47.0
4	65	0.63	129.6	46.9
4	65	0.80	128.2	51.6
4	65	0.83	93.7	47.6
6	98	0.60	143.6	46.8
6	98	0.62	101.1	44.2
6	98	0.75	179.1	50.4
6	98	0.64	144.1	48.6
7	114	0.61	101.3	42.4
7	114	0.60	99.5	44.0
8	131	0.50	152.1	47.1
14	228	0.49	154.0	51.6

Statistical relationships between the number of plants per pot and average stem diameter, between plants per pot and yield of plants per pot, and between stem diameter and weight of plants per pot, were tested using the Cricket software package with a Mac computer. There was no significant statistical relationship between the number of plants per pot and weight of plants per pot. We concluded that individual plants, when thinly spaced, bushed out to fill the available space so that the yield of plants per unit area did not vary significantly.

In contrast, there was a significant relationship between average stem diameter and the number of plants per pot. Linear, quadratic, cubic and logarithmic relationships were plotted and tested for statistical correlations. The best fit to the data was a logarithmic relationship expressed as:

$$y = 1.1064\ X^{-0.30455} \quad R^2 = 0.733$$

in which y = average stem diameter (in cms.)

x = plants per pot (per 0.0613 m^2)

The relationship is shown in Figure 1.

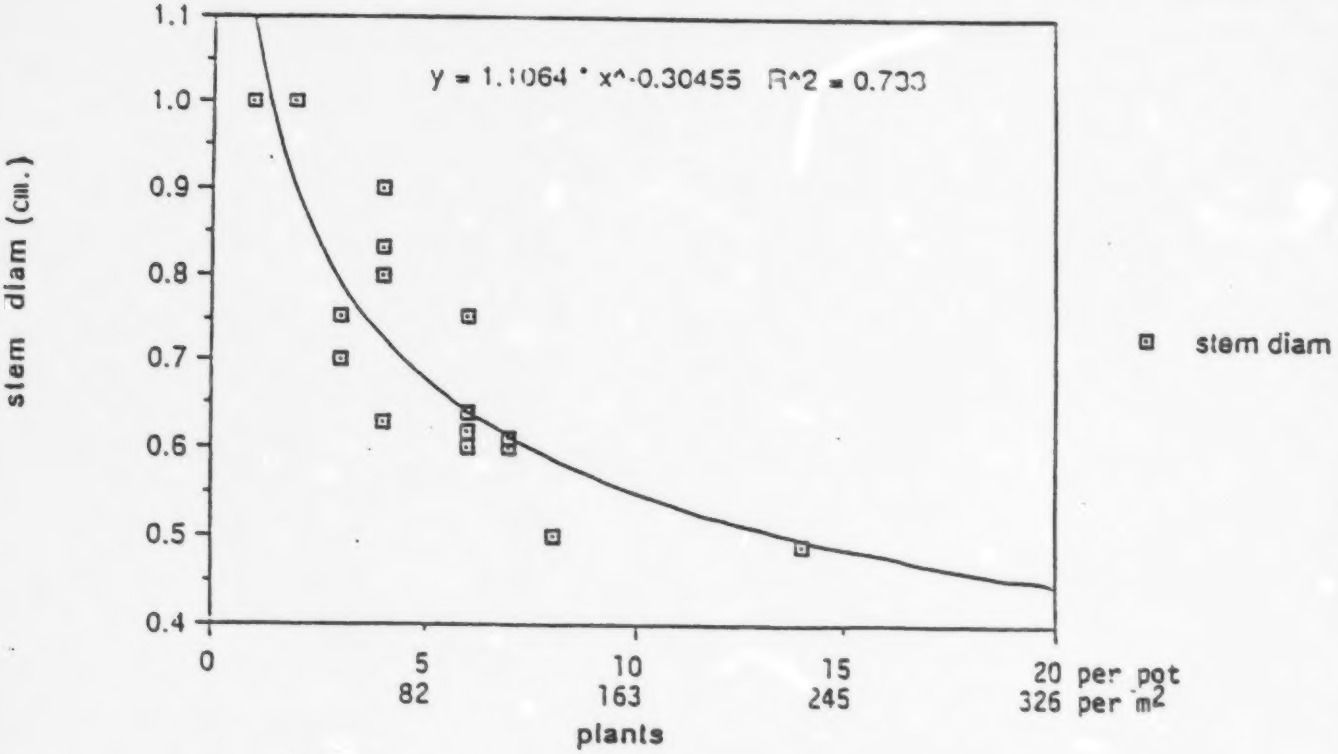

Figure 1. Relationship of average stem diameter of kochia plants to the number of plants per pot.

More data points would be desirable in the range of 10-20 plants per pot (163-326 plants per m^2). However, extrapolation of the data curve to 25 plants per pot (408 plants/m^2) indicated that the curve was very flat beyond that point, i.e., increasing the plant density beyond this point made only small reductions in stem size.

These results are in line with previous investigations. Fuehring (1984) found that kochia yields did not vary much over plant populations ranging from 64-1540 plants/m^2. However, Fuehring recommended that plants be cut before they were toc mature; otherwise, the stems became too thick and woody. Derdall (1988) found that kochia growing at 450-480 plants/m^2 under irrigation gave acceptably small stems (less than 1.3 cm) even at a late stage of maturity.

By growing plants in pots, without competition from plants outside the pots, we may have created a large measure of edge effects. Even so, a significant effect of planting density on average stem size was observed.

The percentage of stems in the plants was investigated to test whether the number of plants per unit area or the thickness of the stems had a significant effect on other aspects of forage quality, e.g. percent of stems.

The results shown in Table 1 did not reveal any tendencies for stem amounts to be effected by planting densities. A wide enough variation in plant density was not available in this experiment to draw further conclusions.

There was no correlation between number of plants per pot and percent stem, nor between stem diameter and percent stem. There was considerable variability in the results and there were few replicates with more than 7 plants per pot into the density where crowding might have an effect. More experiments are needed.

Crude protein content and organic matter digestibility of leaves and stems were determined (Table 2). No correlations were found between the feed value of leaves, stems or whole forage, and planting density. There were wide variations in protein contents of leaves (13.64% - 23.19%) and whole plants (7.75% - 15.50%) and organic matter digestibility of stems (25.97% - 41.89%). There was some evidence that high plant populations and higher yields per pot tended to result in lower protein contents of whole forage and of forage leaves, suggesting inadequate available nitrogen in the soil. The more crowded plants had paler leaves, near the harvest date, than less crowded plants. The porous soil medium used may have caused some leaching of soil nitrogen out of the rooting zone of the plants.

This experiment should be contrasted with Part 2 of this chapter wherein the field experiment at Swift Current was able to achieve a wider range of plant populations.

Table 2. Effects of stand density on the yield and feed value of kochia.

#Plants /pot	Yield g/pot	CP Leaf	CP Stem	Leaf	Stem	CP Whole	Yield g protein /pot	Leaf OMD	Stem OMD	Whole plant OMD
		- - - - - -	- - - - - -	% - - -	- - - - - -	-plants		- - - - - -	- - - %	- - - - - - - - -
1	55.9	23.19	7.16	52	48	15.50	8.66	73.99	35.32	55.43
2	149.2	19.06	4.58	54	46	12.40	18.50	71.92	31.76	53.45
3	110.2	18.17	5.57	57	43	12.75	14.05	70.32	36.14	55.62
3	104.2	18.69	5.73	59	41	13.38	13.94	70.46	37.36	56.89
4	137.6	11.41	3.62	53	47	7.75	10.66	69.86	25.97	49.23
4	129.6	18.87	5.56	53	47	12.61	16.34	71.29	36.86	55.11
4	128.2	14.59	4.57	48	52	9.38	12.03	70.98	39.12	54.41
4	93.7	15.68	5.58	52	48	10.83	10.15	70.60	41.26	56.52
6	143.6	15.16	4.43	53	47	10.12	14.53	69.81	27.98	50.15
6	101.1	18.17	5.14	56	44	12.44	12.58	69.26	36.49	54.84
6	179.1	18.81	6.38	50	50	12.59	22.55	73.08	41.12	57.10
6	144.1	17.78	5.46	51	49	11.74	16.92	72.26	39.15	56.04
7	101.3	15.62	5.41	58	42	11.33	11.48	70.80	41.89	58.66
7	99.5	13.64	4.57	56	44	9.65	9.60	70.79	40.10	57.29
8	152.1	15.73	3.56	53	47	10.01	15.23	73.65	26.62	51.54
14	154.0	14.51	4.31	48	52	9.21	14.18	70.25	37.64	53.29

CP ≡ crude protein
OMD ≡ organic matter digestibility (in vitro)

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Chapter 4

B. EFFECT OF PLANT DENSITY IN THE FIELD ON KOCHIA FORAGE YIELD AND FEED VALUE

Swift Current Research Station

1.0 INTRODUCTION

The results of the pot trial at Saskatoon (see part A of this chapter) showed that planting density had a significant effect on stem diameter of the kochia plants, but had little effect on forage yield or forage feed value. It was necessary to conduct a trial to test the effects under field conditions. The trial described in this section was conducted in 1989 at the Research Station South Farm near Swift Current. In this study, kochia was spring seeded to effect emergence and result in forage stands with the required plant densities without subsequent manipulation. Fertilizer and weed control were adequate and uniform across the plots.

2.0 MATERIALS AND METHODS

The experiment was conducted on a test block within a 30 m by 48 m area on a field which had been summerfallowed in 1988. The loess-derived Swinton loam soil (non-saline) was mechanically pre-worked to depth of 5 cm on June 1st, 1989, using cultivator, harrows and packer. Different seeding rates and equipment combined to ensure randomly varying emergence. Final plant counts per square metre were taken on July 31st at 32 locations scattered throughout the test area. The plant counts and above-ground biomass samples were obtained over the same square metre at each of the 32 locations. Plant densities ranges from 10 to 470 plants/m^2. Results were analyzed as if the experiment was completely randomized.

In addition to biomass samples obtained from the South Farm experiment, six plant samples were gathered from a severely saline site north of Swift Current. These six samples were oven-dried and ground through a mill to pass a 1 mm screen. Sub-samples of the ground material were analyzed for feed value.

3.0 RESULTS

The relationship of plant density to plant yield is shown in Table 1 and Figure 1. If yields were still increasing at the highest plant density observed, the best fitted logarithmic relationship of yield to plant density is expressed by the equation:

$$Y = 29.081\ (X^{0.48972}) \qquad R^2 = 0.887$$

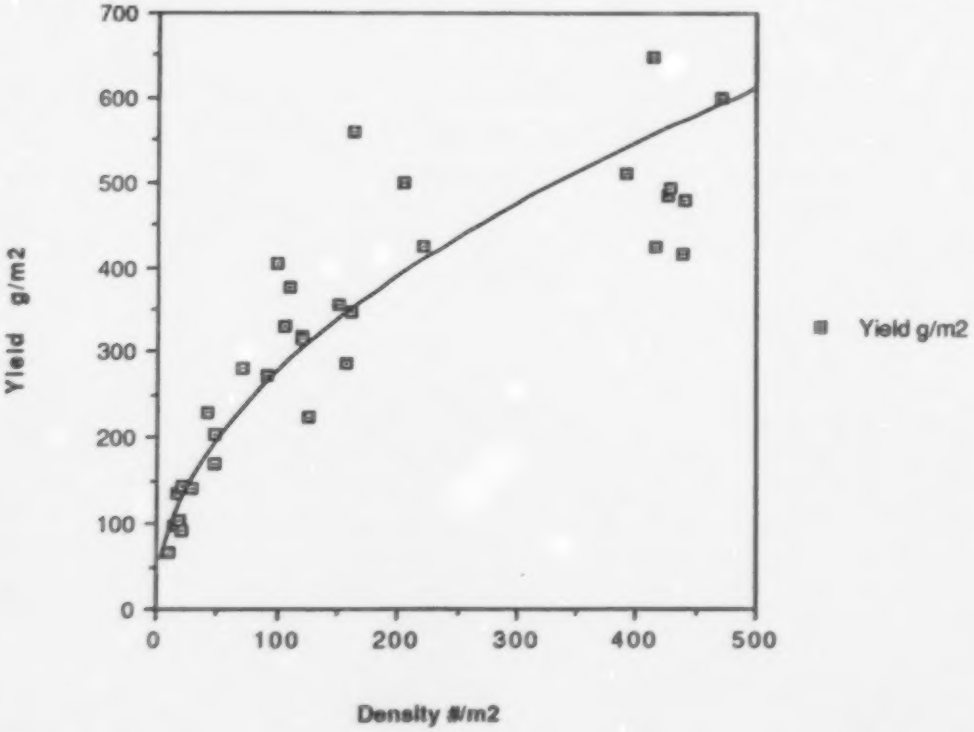
where Y = yield, expressed in g/m^2 and X = plant density in plants/m^2.

Table 1. Yield of kochia forage in relation to plant density.

Density Plants/m²	Yield g/m²	Density Plants/m²	Yield g/m²
		(cont'd)	(cont'd)
10	66	120	317
14	97	125	224
17	134	150	357
18	104	156*	286
20	144	160	347
20	91	163	558
29*	140	204	499
42	229	221	425
47*	205	390*	510
47	168	414	648
70	281	416	425
91	273	426	484
98*	404	427	494
105	331	438	415
109	375	441	478
120	318	471*	600

* Analyzed for feed value.

Figure 1. Kochia Density vs Yield.



These results are in contrast to the results of the pot trial in section A, where no correlation was found between plant yields and plants/m^2. However, the plants in the pot trial were growing in an abnormal situation, and it is felt that the field experiment represents what would be found in a normal field situation. The experiment is complicated by the characteristically irregular emergence of plants under natural field conditions.

The feed values of the six samples analyzed are shown in Table 2. These samples were collected from a severely saline site north of Swift Current (see Materials and Methods section). No significant correlations of feed values to plant densities were found. This is similar to the pot trial in which there was no correlation of plant feed values to plant densities.

Table 2. Feed value of kochia forage at various plant densities.

Plant density (stems/m^2)	Feed Value of Forage (% of dry matter)						
	Ash	Crude Protein	OMD$^+$	Oxalate (water soluble)	Nitrate	Alkaloid	Saponin
44	10.81	10.47	56.1	3.97	-	-	0.15
11	9.82	8.74	52.7	2.91	-	0.002	0.15
41	11.11	10.84	54.4	3.90	-	0.011	0.15
96	11.85	11.92	56.6	4.64	-	0.001	0.15
164	11.52	9.02	50.2	3.68	0.09	-	0.15
1259	11.95	10.48	53.2	4.30	-	0.014	0.19

- = not detected.
+ = organic matter digestibility.

The conclusions from both plant density experiments were that increasing plant populations up to 400 plants/m^2 increased forage yields, reduced the size of the stems, and did not have a negative effect on forage feed value. Thus the higher plant populations, at least up to 400 plants/m^2, had a beneficial effect on kochia forage yield and quality.

Farm trials should be conducted to verify these results and to develop the seeding techniques to obtain such plant populations. Feeding trials would also be desirable to compare the percent of forage intake and stem refusals between fine stemmed forage and coarse stemmed forage.

Chapter 5

EFFECT OF PLANTING TIME (FALL OR SPRING) ON THE YIELD OF KOCHIA FORAGE

Swift Current Research Station

1.0 INTRODUCTION

Wild kochia is naturally sown in the fall. The question arose in our earlier study (Coxworth et al., 1988) as to what was the best time of year to plant kochia. Would spring planting give higher yields than fall planting? Earlier experiments by Green (1988) found that late spring seeding gave substantially higher yields (5609 kg/ha) than early spring seeding (2448 kg/ha) which was similar to late fall seeding (2041 kg/ha). These studies in 1985 at Swift Current were complicated by serious weed problems which appeared to reduce kochia yields. This was particularly the case with early spring or late fall seeding. A tillage operation before late spring seeding killed many weeds, e.g., stinkweed and flixweed, which growth room studies showed reduced the growth of kochia. Our conclusions at that time were that further experiments were required in which tillage operations were used to kill weeds before kochia was planted.

2.0 MATERIALS AND METHODS

The Vance saline site north of Swift Current was used in this study.

The test consisted of four treatments replicated four times on plots 6 m wide and 60 m in length within moderately to severely saline soil. The treatments were as follows:

1) Naturally seeded, fall cultivated (11 October 1988),
spring fertilized (28 April 1989),
2) Fall fertilized, cultivated and seeded (11 October 1988),
3) Early spring fertilized, cultivated and seeded, (28 April 1989),
4) Late spring fertilized, cultivated and seeded (6 June 1989).

Fertilizer was applied to each plot according to soil tests with rates averaging 112 kg/ha of nitrogen and 56 kg/ha of phosphorus. On the naturally seeded plots, the fertilizer was broadcast without mechanical incorporation. On the mechanically seeded plots, the fertilizer was incorporated during cultivation and followed by shallow seeding and packing with a double-disc drill. The seeding rate was set for 4.5 kg/ha. Electrical conductivities of saturated pastes extracted from plot soil samples were generally in the range of 8-12 dS/m.

Estimates of forage production were determined from ground-level cuts of the kochia biomass on August 1st, 1989, before significant leaf loss or seed set. Three 1 m^2 areas were cut in each plot and the forage oven-dried to obtain yields.

3.0 RESULTS

Yields of the dried, above-ground kochia biomass taken from three hand-harvested samples per plot were weighed, averaged, and are shown in Table 1. These data demonstrate that the fall seedings, either natural or mechanical by machine, resulted in better forage stands and yields than did the early spring seedings which, in turn, produced better than the late spring seedings.

Table 1. The effect of seeding dates on kochia dry matter yields (above-ground, oven-dried biomass) grown in 1989 at the Vance site north of Swift Current.

Seeding date and method	Yield* (kg/ha)	Tons/acre (hay basis of 15% moisture)
1. Naturally seeded, fall cultivated and spring fertilized	10206^a	5.24
2. Fall fertilized, cultivated and seeded	10943^a	5.61
3. Early spring fertilized, cultivated and seeded	8948^b	4.59
4. Late spring fertilized, cultivated and seeded	5403^c	2.77

* Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Once cultivated, all plots were relatively free of weeds, suggesting that if the over-winter weeds are eliminated, kochia growing in saline soil can successfully compete with spring-germinated weeds. This appears especially true in years when spring precipitation provides the germinating kochia and seedlings with sufficient soil water during their critical early growth. Studies reported elsewhere in this report (Chapter 6) showed that kochia seeds require near-surface planting and consistent moist soil during germination and early growth to ensure survival. Table 2 presents 1989 precipitation amounts and dates collected during the May through August period relevant to this experiment. The months of March and April were comparatively dry.

Table 2. Precipitation volumes and dates measured in a Canadian Standard Rain Gauge at the Vance salinity site near Swift Current, May through August 1989.

		Precipitation (mm)				Precipitation (mm)	
Date		Measured	Accumulated	Date		Measured (con't)	Accumulated (con't)
May	4	0.6+	0.6	June	2	7.9	64.5
	7	0.4+	1.0		12	73.7	138.2
	11	1.3+	2.3		21	2.5	140.7
	12	17.6+	19.9		26	19.8	160.5
	13	14.4+	34.3		28	3.0	163.5
	14	0.2+	34.5				
	16	2.0	36.5	July	10	1.8	165.3
	19	1.0	37.5		11	14.0	179.3
	24	7.1	44.6		19	26.0	205.3
	26	11.2	55.8		27	trace	
	31	0.8	56.6				
				August	8	6.1	211.4
					28	45.0	256.4
					30	6.1	262.5

+ Data transposed from Agriculture Canada Research Weather Station.

The timing of the 1989 Spring precipitation seemed to favour the fall-seeded kochia over that seeded in the spring. Kochia near Swift Current often germinates in March or April and then enters a very slow growth "rosette" stage until soil water and temperature conditions support more rapid growth. The fastest growth rates characteristically occur following spring precipitation and the elevated air temperatures of June and July. In 1989, the fall-seeded kochia sprouted in April or earlier, as did the seeds sown naturally on the spring-seeded plots (Treatments 3 & 4). Spring cultivations, on April 28th and June 5th, respectively, tended to destroy the naturally-seeded kochia already established. The rains that followed during May and early June proved partially wasteful for the germinating spring seedlings, because their young root systems, especially from the late-spring seedings, were not sufficiently developed to fully capture all the percolating rain water. Thus, the fall-seeded plots derived the greatest benefit from the 1989 weather.

Seeding kochia in late spring (early June near Swift Current) tends to dry the soil to the depth cultivated. Although this contributes to lower forage yields in comparison to that from better-watered seedlings from earlier seedings, two advantages may exist with the late timing: (1) late seeding may give the best weed control in years when snowmelt quantities and spring precipitation are meager or delayed until mid-June; (2) farmers and ranchers may find that late-spring seeding best fits their management schedules. Producers whose spring work keeps them fully occupied during this period might compare the 4 t/ha or more of kochia hay extractable from the 5.4 t/ha of above-ground biomass harvested from the late spring seeding in this experiment with that expected from other late-seeded alternative crops, such as barley or oats, rather than with the potentially higher yields possible from earlier kochia seedings.

Forage growers looking to optimize kochia production on moderately to severely saline soils should consider fall preparation. A late-fall cultivation will control fall-germinated weeds, a major requirement for achieving productive stands of kochia. Ample quantities of naturally-dispersed kochia seed commonly invade most saline sites. Fall cultivation may bury some of these seeds, reducing plant emergence. Such reductions often benefit the resulting kochia stands by keeping plant densities within optimum range. However, if natural seed sources are limited, or if burial by cultivation becomes excessive, fall implement-seeding is an option.

Table 3 presents kochia emergence counts taken on May 11, 1989, in the fall-seeded plots. As expected, naturally-seeded kochia shows the greatest average and variability in emergence. The mechanically-seeded plots produced a more uniform emergence, but averaged 19% less, reflecting the greater opportunity for deep burial of the naturally-sown seeds during cultivation.

Table 3. Emergence of kochia plants counted on May 11th, 1989, for natural and implement seeding the previous fall Vance site.

Sample	Naturally seeded #/0.5 m^2	Implement seeded #/0.5 m^2
1	296	373
2	560	478
3	407	366
4	653	329
mean	479 (±159)*	386.5 (±64)*

* Standard deviation in parenthesis.

Fall cultivation reduces vegetative cover and has commonly been linked with increased exposure of the soil to erosive forces, especially from wind. Saline sites typically consist of scattered low spots, relatively small in area, and characteristically exhibiting wetter soils. This combination acts to limit the impact of cultivation on the exposure of saline sites to erosion. Thus, in general, fall cultivation imparts less erosion risk on saline soil than when practised on non-saline soils.

Chapter 6

EFFECTS OF SEEDING DEPTH AND RAINFALL PATTERNS ON KOCHIA SEEDLING EMERGENCE AND SURVIVAL

Swift Current Research Station

1.0 INTRODUCTION

Kochia establishment, especially on saline soils, can be very difficult. This study was conducted to attempt to separate the effects of soil surface salts, amount and time of precipitation, and the depth of seed placement. In Chapter 3 (q.v.) we have described studies on the effects of removal of calyx and pericarp from the seed, and the effects of seed size, on kochia emergence and eventual forage yield and feed value. This present chapter describes studies using kochia seed with calyx and pericarp intact, and not segregated for seed size. This is the form of seed which has been used in all field experiments and farmer trials.

2.0 MATERIALS AND METHODS

Mixed kochia seed from a population of wild, unselected plants was used. The seed was used as collected by the combine, with the pericarp and most of calyx intact.

1. Seed was planted in a non-saline Swinton clay loam topsoil at various depths: surface, and 1, 2, 3 and 4 cm below the soil surface. The samples were moistened to ensure the soil was kept at close to field capacity throughout the experiment. Germination was conducted at 20°C in the greenhouse. (The germination vitality of the seed used was previously

established by germination trials in Petri dishes with moistened filter paper growth medium.). Emergence and growth of the seedlings was monitored over a two-week period until emergence was judged complete.

2. Based on the results of trial 1, the precipitation regime experiment was conducted in the greenhouse using kochia seed and soil gathered from the Vance salinity site north of Swift Current. Wooden flats, 396 mm by 344 mm by 100 mm deep were filled with a mixture of 25% quartz sand, 25% Swinton loam and 50% saline (Vance) soil. The electrical conductivity of a saturated paste extract from the mixture equalled 23 dS/m. Seeds were placed near the surface and subjected to four simulated rainfall (irrigation) regimes scheduled in two phases (I, II):

   i) Surface was initially moistened sufficiently to germinate kochia seed as if in a non-saline environment, and this condition was maintained throughout Phase I and II to the end of the experiment, [a dry:dry regime];

   ii) Surface was maintained as in Treatment i during Phase I, but received increased water in Phase II, [a dry:wet regime];

   iii) Surface was initially irrigated with more water than necessary to germinate seeds if in a non-saline environment, and this condition was maintained throughout Phase I and II to the end of the experiment, [a wet:wet regime];

   iv) Surface was maintained as in Treatment iii during Phase I, but received only sufficient water for germination as if in a non-saline environment during Phase II, [a wet:dry regime].

3.0 RESULTS

Results from the depth-of-seeding study demonstrated that seeds placed at or near the surface produced the highest percentage of vigorous plants (Table 1).

Table 1. Percent plant emergence from kochia seeds, in randomly-replicated lots of 100, placed at specific depths in Swinton clay loam topsoil (Germination vitality of the seeds was separately tested and equalled 75%).

Seed Depth	Emergence (%)
Soil surface	63
1 cm below surface	43
2 cm below surface	4
3 cm below surface	2
4 cm below surface	0

In the experiment on saline soil, testing the effect of different rainfall regimes on the emergence of kochia, kochia emerged from the "wet:wet", "wet-dry", and the "dry:wet" regime treatments. Kochia seedlings did not establish from the dry:dry, rainfall regime (Table 2). Phase I of the experiment covered the first 15 days. Phase I also coincided with the first of three response periods. Phase II began on the 15th day and lasted until the 56th day, and resulted in two response periods, #2 and #3. We defined the experimental response periods as (1) the Phase I emergence, (2) the salt leaching, and (3) the Phase II emergence periods. These periods are arranged chronologically in Table 2 by the three groupings of data ending at the 15th, the 24th, and the 56th lapsed day after seeding.

Table 2. Kochia emergence (%) averaged from four greenhouse flats per treatment in saline (23 dS/m) media and irrigated water volumes (mm) through the indicated lapsed days after seeding on April 3, 1990.

	Treatment							
Lapsed days from 3 April 1990	1	dry:dry	2	dry:wet	3	wet:wet	4	wet:wet
	%	mm	%	mm	%	mm	%	mm
		dry		dry		wet		wet
3	0	9	0	9	7.0	12	8.75	12
6	0.25	12	0	12	13.5	18	18.0	18
9	0.75	18	0.25	18	24.0	26	29.25	26
12	"	20	"	20	24.5	35	29.5	35
15	"	22	"	22	25.5	41	"	41
		dry		wet		wet		dry
18	"	26	0.5	37	"	51	29.75	44
24	0	31	3.75	44	25.75	59	26.75	48
30	0	34	14.25	51	26.75	66	25.5	51
36	0	41	17.75	63	28.5	78	24.75	59
42	0.5	48	23.75	76	29.75	91	"	66
45	"	51	25.75	82	30.75	97	11.0	69
51	0	54	28.75	91	30.25	106	9.5	72
56	0	59	31.75	98	30.0	113	5.25	72

The first response period showed different emergence depending on whether Phase I was "wet" or "dry". Emergence began on the third day after seeding and averaged 7.0 and 8.75 kochia plants per flat when irrigated with 12 mm of water per unit area (wet) compared to 0 plants/flat following 9 mm of water (dry). This pattern continued until day 15 with a "wet" irrigation rate of

2.7 mm per day and a "dry" rate of 1.5 mm/day. The first period ended with over 25% of the planted seeds emerged from the wet flats, while only 4 out of 800 seeds emerged in the dry flats. We speculate that the lower irrigation rate was also insufficient to keep salts in the soil solution from moving upward toward the evaporating soil surface.

The second response period spanned 10-12 days and defined the time between initiation of Phase II and the beginning of appreciable kochia emergence in response to a wetter regime. Irrigated volumes averaged 0.8 mm per day in Phase II "dry" flats and 2.4 mm/day in the Phase II "wet" flats. The wet:dry flats lost about 3 viable kochia plants per flat as might be expected, while the dry:wet flats gained only about 3 newly emerged plants per flat, well below the comparable Phase I response. We speculate that excess salts concentrated in the top centimetre of the soil hindered emergence and had to be leached downward before germinating plants could establish.

The Phase II emergence period (Period 3) began slowly as kochia emerged in the dry:wet flats and died in the wet:dry flats. Irrigation rates during the first half of this period averaged about 1.15 mm/day for "dry" and 2.1 mm/day for "wet" flats. The influence of salt movement undoubtedly extended this period over some 29 days (until day 56) when we deemed the dry:wet emergence as having reached its maximum.

Results from this experiment suggest that kochia emergence on moderately or severely saline soil relates closely to ambient weather. This relationship stems from the need for shallow, near-surface seeding depths for effective germination.

Soil water and solute concentrations near soil surfaces are greatly affected by evaporation and precipitation. Thus, the simulated rainfall rates leading to the emergence observed in the experiment described above should not be taken as fixed. Rather, they reflect the requirements resulting from the specific ambient environmental conditions and solute constituents imposed by the test, and which will vary as conditions change in time and location.

These results demonstrated the minimum requirements kochia needs for successful establishment in severely saline soil:

- very shallow seeding;
- moist surface soil while the kochia seed germinates, and the seedling establishes roots sufficiently deeply to keep ahead of the drying out of the surface soil, as salts more in the early spring or after a spring rain.

Similar results have been found in Texas (Everitt, Alaniz and Lee, 1983). Seedling emergence for kochia seeds left exposed on the soil surface (74%) was significantly higher than for those planted at a depth of 3 mm (57%). Kochia seed germinated just as well at 5°C (92%) as at 20°C (92%), both of which were higher than germination at 30° (74%) or 35° (30%). Kochia germination was just as high (92%) in saline environments (16 mmhos/cm conductance) as in non-saline environments. Kochia seedlings were reported to be only slightly damaged by temperatures as low as -13°C (Eberlein and Fore, 1984). Kochia seed germination was only slightly reduced at pH2 and 12 as compared with germination at intermediate pH's. Kochia seed germination was not reduced at osmotic potentials up to -8 bars, implying that germination was not severely affected by moisture stress. However, the Swift Current trials (Table 2) indicated that seedlings needed to find moisture quickly to survive.

The pattern of these findings and the results reported in Chapter 3 and 5 imply the following:

- kochia needs to be surface or very shallowly seeded;
- fall or early spring planting is best so that kochia can germinate in moist surface soil as soon as the frost leaves the ground. Germination and early growth can occur at low temperatures. Seedlings can then establish before the soil warms up as spring advances and the surface soil dries out;
- cultivation in fall is desirable to control winter annuals such as stinkweed and flixweed;
- removal of the calyx from seed helps germination and plant growth.

No seed dormancy has been found in kochia (Everitt, Alaniz and Lee, 1984). Thus planted kochia seed that does not germinate the first year is unlikely to cause problems in other crops in subsequent years.

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Chapter 7

EFFECT OF FERTILIZER ON KOCHIA YIELD AND FORAGE FEED VALUE

Swift Current Research Station

1.0 INTRODUCTION

Previous studies (Coxworth et al., 1988, Chapter 10) have shown that kochia responds well to added nitrogen fertilizer, when kochia was grown on saline soils. Soil disturbance was an important factor in obtaining a good yield of kochia, particularly when kochia was grown after kochia (Coxworth et al., 1988, Chapter 5). Soil disturbance and fertilizer application interacted positively to raise kochia forage yields (Coxworth et al., 1988, Chapter 5).

This chapter reports on kochia's response to N fertilizer at the Vance salinity site north of Swift Current during 1989. Preliminary response data obtained in 1987 and 1988 are included for comparison. Feed values of the kochia forage harvested in 1989 and 1987 are also compared.

2.0 MATERIALS AND METHODS

Field trials were conducted at the Vance salinity sites 15 km north of Swift Current. As in previous years (1987, 1988), the plots were disced and cultivated in the fall of 1988 to prepare for the 1989 season. Fall field preparation was essential for weed control and to avoid any field operations in wet areas in the spring. Treatments consisted of 4 replications of 4 rates of spring-applied nitrogen as ammonium nitrate: 0 lb/ac., 50 lb/ac (56 kg/ha), 100 lb/ac (112 kg/ha), 150 lb/ac (168 kg/ha). Each treatment also received a blanket application of 50 lb/ac (56 kg/ha) of P_2O_5. Following fertilizer incorporation, the plots were seeded and packed with a double-disc drill. The plot size was 3 m by 30 m, aligned up a gentle slope. The soil was sampled prior to seeding in the spring and at post-harvest to determine nutrient and salt status.

In 1987, only three rates of N fertilizer were used (0,56 and 112 kg N/ha). In 1988 and 1989 four rates of N fertilizer were used as described above.

Unselected Saskatchewan kochia seed, obtained from the previous year's kochia grown at the Vance site was seeded at a rate of 4.5 kg/ha with a double disc press drill. The seed was metered directly onto the soil surface and shallowly covered by harrowing using diamond tooth harrows (1987) or by packers after the double-disc drill (1988, 1989).

Three kochia samples, each hand cut at ground level from metre squares, were collected from each plot at different slope positions. The samples were oven-dried, weighed and mean dry matter yields determined for each plot. The three samples from each individual plot were combined, hammermilled through a 1.25 cm screen and ground through a 1 mm screen on a Wiley Mill. Representative sub-samples from each plot were submitted to the Feed Testing Laboratory of the University of Saskatchewan for analysis for moisture, crude protein (CP) [A.O.A.C., 1984, (N x 6.25)], Ash (A.O.A.C., 1984a), and in vitro organic matter digestibility (IVOMD) [Troelsen, 1971; modification of the method of Tilley and Terry, 1963]. Feed analyses were not done in 1988 due to lack of funds.

The results for yield (1989) and nutritive value (1987 and 1989) were statistically analyzed by a two-way analysis of variance and Duncan's new multiple range test.

3.0 RESULTS

Average salinities for saturated pastes extracted from soil samples, taken at three locations per plot before the 1989 fertilizer applications and seeding, are listed in Table 1. Mean values for each replicate block range from 7.6 to 11.1 dS/m, ie., from moderately to severely saline, and support the use of a randomized block statistical design. Variance in salinity within the blocks proved less than that across the blocks. The statistical analysis of salinity by treatment plots presented in Table 2 failed to reject the premise of uniform saline conditions within each replicate block suggesting that salinity would not confound the fertility test.

Table 1. Average electrical conductivities of saturated paste extracts, obtained from soil cores in 15 cm depth increments to 90 cm, three holes per plot, 16 plots, Vance Site north of Swift Current, 8 May 1989.

Plot	Block replicate	Sample$^+$ size	Nitrogen treatment		Electrical conductivity
		#	kg N/ha	(lb N/ac)	dS/m
1	1	17	168	(150)	9.1
2	1	16	0	(0)	7.0
3	1	18	112	(100)	7.4
4	1	16	56	(50)	6.6
Mean*	1				7.57^a
5	2	15	168	(150)	8.2
6	2	15	112	(100)	9.1
7	2	14	56	(50)	7.8
8	2	14	0	(0)	10.3
Mean*	2				8.86^a
9	3	17	112	(100)	9.2
10	3	14	0	(0)	10.5
11	3	14	56	(50)	12.1
12	3	13	168	(150)	13.0
Mean*	3				11.10^b
13	4	14	56	(50)	11.2
14	4	14	168	(150)	10.5
15	4	12	112	(100)	10.3
16	4	13	0	(0)	9.9
Mean*	4				10.50^b

+ Some soil layers below 60 cm were not able to be sampled.

* Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Table 2. Mean electrical conductivities of saturated paste extracts obtained from Vance site soil samples and averaged by treatment plots.

Sample size⁺	Nitrogen treatment		Mean* electrical conductivity
#	kg N/ha	(lb N/ac)	dS/m
57	0	(0)	9.35^a
58	56	(50)	9.36^a
62	112	(100)	8.88^a
59	168	(150)	10.08^a

+ Some soil layers below 60 cm were not able to be sampled.

* Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

Nitrate nitrogen and phosphate phosphorus supplies in the upper 60 cm of the 1989 plots were sampled just before N fertilizer applications and kochia seeding. Table 3 contains the sample results averaged by treatment plots. The 40 kg/ha or less of available N throughout the plots fell short of kochia requirements, confirming the suitability of the test location for N fertilizer response trials.

Table 3. Mean NO_3-N and P_20_5-P values in kg/ha obtained from May 1989 soil cores 0-60 cm deep, three per plot, averaged by treatment plots.

Nitrogen treatment		Sample size	Mean* NO_3-N	Mean* P_2O_5-P
kg N/ha	(lb N/ac)	#	kg/ha	kg/ha
0	(0)	12	39.1^a	66.6^a
56	(50)	12	38.8^a	75.3^a
112	(100)	12	37.1^a	62.1^a
168	(150)	12	40.0^a	81.3^a

* Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

The 1989 yields determined from hand-harvested square metre forage cuts at ground level, averaged from three samples per plot, taken 79 days after seeding, are shown in Table 4 along with preliminary 1987 and 1988 data. The 1989 responses to increasing levels of N record only one significant improvement in yield: that resulting from the initial increment of 56 kg N/ha of added ammonium nitrate. Additional increments of N fertilizer, totalling 112 or 168 kg N/ha, produced no significant yield enhancement. Although not statistically significant, a trend in forage yield response with a peak at 112 kg N/ha could be identified.

Table 4. Effect of N fertilizer additions on the dried yield of above-ground kochia biomass (mean of 3 samples) grown on moderately to severely saline soil, Vance site north of Swift Current, 1989, plus preliminary 1987 and 1988 data.

Fertilizer treatment		Mean yield of hand-sampled, above-ground kochia biomass oven-dried square metre sample (kg/ha)		
kg N/ha	(lb N/ac)	1987	1988	1989
0	(0)	4150	6860	5808^{a}
56	(50)	6510	8070	7422^{b}
112	(100)	7560	9730	7835^{b}
168	(150)	ND	10150	7583^{b}

* Means within a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.
ND = not determined.

Table 2 of Chapter 5 shows the measured precipitation recorded during the May through August period of 1989. Over 136 mm of precipitation fell between 11 May and 12 June. This rainy period encompassed the 23 May cultivation and seeding initiating this experiment. Surface runoff was thought to be minimal, allowing ample opportunity for infiltration of the spring precipitation. Wet soils contributed to the difficulty of controlling the growth of early-sprouted volunteer kochia by cultivation; fortunately, the plots were free of annual and spring weeds. Besides ensuring an excellent stand of kochia, the rains undoubtedly caused some $N0_3$-N to be leached below the root zone. Certainly, the low nitrate levels sampled in the top 60 cm of the treatment plots after harvest (Table 5) leads to an inference that N in the upper root zone was either used by the kochia or leached to lower levels.

Table 5. Mean NO_3-N and P_20_5-P values in kg/ha obtained in 1989 from post-harvest soil cores 0-60 cm deep, three per plot, averaged by treatment plots.

Nitrogen treatment		Sample size	Mean* No_3-N	Mean* P_2O_5-P
kg N/ha	(lb N/ac)	#	kg/ha	kg/ha
0	(0)	12	30.6^a	37.4^a
56	(50)	12	22.1^a	37.0^a
112	(100)	12	28.1^a	50.0^a
168	(150)	12	36.4^a	58.5^a

* Means with a column with the same superscript are not significantly different at the 5% level according to Duncan's New Multiple Range Test.

The mean 1989 treatment yields of kochia biomass fertilized at the 56, 112, and 168 kg N/ha rate equalled 7.4, 7.8, and 7.6 t/ha, respectively. If an overall mean of 7.6 t/ha represents these yields, and if this mean is compared with those yields obtained in the adjacent planting-time experiment at the same site

(Chapter 5), a pattern exists resulting in decreasing yield of kochia biomass with later seeding dates:

seeding date:	11 Oct 88	28 Apr 89	23 May 89	6 Jun 89
above-ground, dried biomass:	10.9	8.9	7.6	5.4 t/ha

From this pattern, one might conclude that beyond the N addition of 56 kg/ha, $N0_3$-N availability did not limit kochia biomass production as greatly as that imposed by the year's weather conditions. Weather controls soil water and temperature regimes. Other factors which may interact with plant response to nitrogen include seed source, nutrients required by kochia, and root-zone salinity.

The CP, ash, and oxalate contents (Table 6) were all significantly increased by the addition of nitrogen fertilizer in 1987. There was no significant affect on the IVOMD of kochia.

The CP content of the kochia forage was very low, consistent with the hypothesis that the kochia was cut at too late a stage of maturity in 1987. The highest rate of N fertilizer applied (112 kg N ha^{-1}) improved both yield and CP, but still did not cause the development of detectable levels of nitrate in the forage (Table 6).

Table 6. The effect of nitrogen fertilization at seeding (May 15) on the nutritive value of Saskatchewan kochia grown near Swift Current in 1987.

Nitrogen fertilizer rate (kg ha^{-1})	CP	Ash	IVOMD	Oxalate	Nitrate
	- - - - - -	- - - - - -	% of dry matter	- - - - - -	- - - - - -
0	7.5^{a}	10.9^{a}	52.3	1.7^{a}	negative[1]
56	8.3^{b}	11.1^{ab}	51.9	1.7^{a}	negative
112	10.2^{c}	11.8^{b}	52.7	2.2^{b}	negative
Significance of fertilizer effect	**	**	NS	**	

Means within a column with the same letter in the superscript are not significantly different ($p<0.05$) according to Duncan's New Multiple Range Test.

[1] Spot test for nitrate was negative, therefore quantitative analysis were not done.

CP ≡ crude protein
IVOMD ≡ in vitro organic matter digestibility

In 1989 the effects of N fertilizer on the feed value of kochia were similar to the effects in 1987 (contrast Table 6 with Table 7).

Table 7. The effect of different levels of nitrogen fertilization on the nutritive value of kochia grown near Swift Current in 1989.

Nitrogen (kg N/ha)	CP	IVOMD	Ash	Oxalate	Nitrate
	- - - - - - -	- - - - - - -	% of d.m.	- - - - - - -	- - - - - - -
0	11.9^{a}	54.1	8.1^{a}	1.6^{a}	0.00^{a}
56	12.2^{a}	53.4	11.0^{ab}	2.1^{ab}	0.01^{a}
112	13.0^{ab}	53.5	12.6^{bc}	2.6^{b}	0.05^{a}
168	13.7^{b}	54.5	14.4^{c}	3.5^{c}	0.25^{b}
Significance of fertilizer effect	**	NS	**	**	**

** highly significant ($p>0.01$).
NS no significance.

Means within a column with the same superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$).

Some differences were apparent between 1987 and 1989. In both years the amount of crude protein (CP) increased even at the highest rate of N fertilizer addition. Although the nitrate content of the 1989 forage also increased with increasing rates of N fertilizer, amounts were well below allowable levels. For additional insurance, livestock feeders should submit their kochia feed for nitrate analysis and only feed the kochia as part of a mixed ration.

Oxalate content increased in both years with increasing CP content. A strong positive correlation was observed previously between oxalate content and protein content (Kernan and Coxworth, 1988). Ash content also increased with increasing N fertilizer.

The most cost effective rate of N fertilizer was the first 56 kg N/ha (Table 4). Higher rates of N fertilizer were not as cost effective.

Our conclusions are that soil disturbance (as in the fall of each year in this study) and modest rates of N and P fertilizer will result in good yields and of kochia. It should be noted that these studies were done with mid-spring planting dates. Other studies in this report (see Chapter 5) have shown that fall or early spring seeding frequently increases yields.

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Chapter 8

INTERPLANTING KOCHIA WITH BARLEY EFFECTS ON YIELDS OF FORAGE AND FEED VALUE

A. EXPERIMENT WITH KOCHIA INTERPLANTED WITH BARLEY IN A NON-SALINE SOIL (POT TRIAL)

E. Coxworth and A. Mair

1.0 INTRODUCTION

A number of farmers have experimented with interplanting kochia with barley. In some instances farmers will pay more for kochia hay mixed with barley whole crop hay than for kochia hay. From animal feeding trials (Coxworth et al., 1988 Chapter 7), it was known that kochia should be diluted with other feed so that it is no more than 50% of the maintenance ration for beef cows. Thus there could be advantages in interplanting kochia with barley (the most saline tolerant cereal) to provide a mixed annual forage from saline soils.

Two experiments were carried out:

A. Kochia was interplanted with barley in various proportions of number of plants of each species per unit area. The crops were planted in a non-saline soil mixture in large pots placed at ground level out of doors. This experiment is described in this section of the chapter. The plants in the pots were watered to avoid moisture stress.

B. In the second experiment, kochia, barley and kochia-barley intercrop were planted in 1989 at the Vance soil salinity site near Swift Current. The plants were harvested at normal hay harvest stage for kochia and the yields and feed values determined. This experiment is described in section B of this chapter.

The following pot experiment was carried out to study the effects of kochia interplanted with barley, when grown in non-saline soil with no growth restrictions of soil moisture or soil fertility.

2.0 MATERIALS AND METHODS

A mixture of five parts soil (a sandy loam obtained from Dressler Landscaping, Saskatoon, Sask.), one part sand, and one part vermiculite was prepared at 50% field capacity in 607 cm^2 surface area (16 litre volume) planting pails. At 6.5 cm below the soil surface, 11-51-0 fertilizer was added at a rate of 45 kg P_2O_5/ha (0.536 g/pot) and urea was added to make up 100 kg N/ha (0.945 g/pot).

Twenty pots were prepared and consisted of four replicates of 100% kochia, 70% kochia + 30% barley, 30% kochia + 70% barley, 50% kochia + 50% barley, and 100% barley, 10 plants/pot, equalling approximately 165 plants/m^2. The kochia was planted 0.5 cm deep and the barley was planted 4 cm deep. The kochia seed used was a limited shattering selection from one plant grown in Saskatoon, Saskatchewan, and the barley was Harrington variety.

The experiment (established as a randomized complete block) was set directly outside and the pots sunk in the ground to soil level. During the first two weeks, there was more than enough precipitation and the plants did not need watering. Plants were then watered to maintain the soil at about 50% field capacity.

The plants were grown for 9 weeks. At harvest the kochia was in the flower state and the barley heads were in the soft dough stage. During the growing period there were considerable numbers of different types of insects disturbing the plants. Some plants showed signs of stress and eaten leaves (principally barley). By week 8 the plants (particularly the kochia) were very yellow and appeared stressed (probably nitrogen deficiency). We therefore added an additional 0.945 g urea/pot. There was a noticeable amount of improvement (increased greenness of leaves) a few days after the urea application.

Wet weights were recorded, the plants were dried in a forced air drying oven at 30°C for three days. The air dry weight of plants was used for statistically analysis.

3.0 RESULTS AND DISCUSSION

The kochia was significantly affected by the barley, but the barley was not affected by the kochia (see (Tables 1 and 2). Total yield is shown in Table 3.

Kochia was severely suppressed by interplanting with barley at all proportions of kochia: barley (Table 1). Barley was not significantly suppressed by kochia (Table 2). As the number of barley plants/pot decreased, individual barley plants increased in weight. When total yields of mixed forages were compared, the proportion of barley: kochia did not significantly affect yields.

Table 1. Effect on kochia growth and yield when interplanted with barley.

Treatment	Height at Harvest (cm)	Yield (g/pot)	Yield (g/m^2)	Weight (g/plant)
100% kochia	53.0^{c}	57.5^{b}	949.0^{b}	5.8^{b}
70% kochia	43.8^{b}	12.0^{a}	200.4^{a}	1.7^{a}
50% kochia	41.2^{a}	7.6^{a}	126.1^{a}	1.5^{a}
30% kochia	28.8^{a}	2.7^{a}	44.5^{a}	0.9^{a}
Significance of effect	**	**	**	**

** highly significant ($p>0.01$).

Means within a column with the same superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$).

Table 2. Effect on barley growth and yield when interplanted with kochia.

Treatment	Height at Harvest (cm)	Yield (g/pot)	Yield (g/m^2)	Weight (g/plant)
100% barley	59.5	45.8	755.5	4.6^{a}
70% barley	56.8	41.9	690.9	6.0^{ab}
50% barley	56.5	63.1	628.9	7.6^{b}
30% barley	59.8	34.1	562.2	11.4^{c}
Significance of effect	NS	NS	NS	**

NS no significance.
** highly significant ($p>0.01$).

Means with a column with the same superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$).

Table 3. Effect on total yield of barley plus kochia.

Treatment	Total Yield (g/m^2)
100% barley	755.5
70% barley + 30% kochia	735.4
50% barley + 50% kochia	755.0
30% barley + 70% kochia	726.6
100 of kochia	949.0
Significance of effect	NS

NS = no significance.

This is a one-way ANOVA statistical analysis.

Because there was high variance in the replicates of 100% kochia, statistical analysis showed no significance for total yield of barley plus kochia. The tables shows that even with a higher percent of kochia to barley, the final yield was only slightly changed.

Using non-saline soil was likely an advantage to the barley growth. Under these conditions barley suppressed kochia when they were planted together. Depending upon weather conditions and moisture, cereals planted in saline areas would make varying degrees of establishment until the stress of heat, high salts and drought would severely restrict their growth and bring on the rapid growth of volunteer kochia (Hanson, 1988). Thus this type of interplanting experiment should be repeated using saline soils in the field (Section B).

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Chapter 8

B. INTERCROPPING OF KOCHIA WITH BARLEY ON A SALINE SOIL AT SWIFT CURRENT IN 1989

Swift Current Research Station

1.0 INTRODUCTION

Tests in 1986 on Darald Marin's farm (Radville, Sask.) showed that Saskatchewan kochia and durum wheat could be seeded, grown and harvested for seed on the same land. Tests in 1987 on the Marin farm and the Vance farm (Swift Current area) demonstrated that kochia and barley could also be grown together. This study was designed to compare yields and feed values of kochia: barley hay mixture compared to kochia alone or barley alone. The experiment was established somewhat upslope of other kochia experiments at the Vance farm saline gradient site north of Swift Current so as to try and place the experiment in only slightly saline soil to ensure that the barley would yield reasonably well.

2.0 MATERIALS AND METHODS

A comparison experiment was established in 1989 at the Vance salinity site on degraded Swinton loam soil averaging about 12 dS/m. Three treatments were statistically replicated with three plots each of barley (Harrington), kochia (Saskatchewan seed), and barley-kochia mix, all seeded on barley stubble from 1988 studies. Each plot was 5 m wide by 30 m in length. The plots were cultivated and prepared for seeding on May 31, 1989. Kochia and barley were then seeded at the standard rate and depth, (4.5 and 80.6 kg/ha and 0.5 and 4.4 cm), respectively. All treatments received 90 lb/ac (101 kg/ha) of 11-51-0 fertilizer as indicated by soil nutrient tests. Hay was cut with a haybine and baled. Crop growth in these plots was well below average, and together with untimely post-harvest rainfall, resulted in reduced yields. Although all the hay cut from replicate plots of the same treatment was combined, the total quantity of forage was still insufficient for standard bale binding; thus, forage yields between treatments could only be compared in relative terms.

In another test, conducted at the Vance salinity site, plots of barley and plots of kochia were grown independently in soils with saturated paste electrical conductivities varying about a 10 dS/m mean. Some border areas between these plots grew barley and kochia in approximately a 50%:50% mixture in plant numbers. Above-ground biomass yields were sampled from 9 cuts from one-square-metre areas, 3 each representing pure kochia, pure barley, and the 50:50 mix. Samples were oven-dried, weighed and reflect fairly the productive capability of barley-kochia inter-cropping on a saline soil near Swift Current in 1989. Yields were sufficient to sample for forage feed value analyses.

3.0 RESULTS

Although forage yields from the specific barley-kochia experiment were not comparable in absolute terms, they showed greater production with the kochia than with the barley. Kochia biomass exceeded that from the barley by approximately 35% and that from the barley-kochia inter-planting by about 5%.

Results from the adjacent test involving barley and kochia seedings are averaged in Table 1. These averages closely represent those obtained from companion cropping trials observed in previous years. Where barley and kochia grow together on saline soil, yields are only slightly reduced in comparison to those from pure stands of kochia. These data reflect the competitive advantage of kochia at the expense of its barley companion in saline environments. As shown in the pot trial, the advantage seems to shift to the barley in non-saline soil.

Table 1. Comparative biomass (oven-dried, above-ground) yield of kochia, barley and kochia-barley mixture, Vance site north of Swift Current, 1989.

	Above-ground biomass yield (kg/ha) from m^2 cuts)			
Treatment	Sample: 1	2	3	average*
100% kochia	5550	6890	5260	5900^a
50:50% barley-kochia intercropped	5970	5540	5010	5507^a
100% barley	2720	3160	3360	3080^b

* Means within a column with the same superscript are not significantly different according to Duncan's New Multiple Range Test (p>0.05).

Average feed values from analyses of forages grown on barley, barley-kochia, and kochia plots are listed in Table 2. Crude protein percents were not significantly different between the two forages and their mixture. Nitrate levels appeared to be the greatest in pure kochia, but the high variability between samples could not rule this difference as significant. However, elevated percents in kochia ash, oxalate, and in vitro organic matter digestibility proved to be significant. From the ash and oxalate contents, we estimated that the kochia biomass of the mixed feed was about 80%.

Table 2. The effect of companion cropping kochia with barley on feed value.

Forage	Ash	IVOMD	CP	Oxalate (water soluble)	Nitrate
	-% of dry matter-				
Barley	10.8^a	56.1^a	15.3	0.0^a	0.3
Barley-kochia	14.5^b	59.4^{ab}	15.7	2.9^b	0.1
Kochia	15.5^b	66.3^b	16.2	3.5^b	1.1
Significance of effect	**	**	NS	**	NS

** highly significant ($p>0.01$).
IVOMD = In vitro organic matter digestibility.
CP = Crude protein.
NS no significance.

Means within a column with the same superscript are not significantly different according to Duncan's New Multiple Range Test ($p>0.05$).

This experiment indicates that intercropping of kochia and barley can be done on saline soils. On non-saline soils, with adequate moisture, barley will dominate and suppress kochia growth (part A of this chapter). On saline soils, kochia will tend to dominate (part B of this chapter). In a field mosaic of saline and non-saline areas, barley green feed would tend to dilute the high ash and oxalate of the kochia hay (see Table 2 of part B).

Chapter 9

STUDIES ON THE EFFECT OF STAGE OF MATURITY ON THE NUTRITIVE VALUE OF KOCHIA HAY GROWN ON SALINE SOIL

J. Knipfel and E. Coxworth

1.0 INTRODUCTION

The purpose of this study was to obtain further information on the effect of different harvesting stages on the feed value of kochia hay, grown on saline soil, for cattle and sheep. A 100 farmer survey indicated that many farmers in the southern part of Saskatchewan were feeding kochia hay to cattle (Hanson, chapter 1 of this report). They had expressed an interest in obtaining more information about the best stage of maturity to harvest kochia so as to optimize feed value. It was evident that more information needed to be available and sent to farmers about the results of this and previous studies on the effects of harvesting kochia at different stages of maturity.

Previous Studies

1. Studies in Texas on kochia grown on non-saline soil

1.1. Sherrod (1971) studied wild kochia grown in the northern area of Texas (Lubbock, Texas panhandle) in the late 1960's. Kochia was harvested at prebloom, midbloom and full bloom and investigated for yield, percent leaves and stems, and feed value (Table 1).

Table 1. Composition, leaf and stem amounts, and yield of kochia harvested at three stages of maturity (adapted from Sherrod, 1971).

	Prebloom	Midbloom	Full bloom
Yield (kg/ha)	3548	8708	11327
Leaves (%)	54.6	44.6	28.0
Stems (%)	45.4	55.4	72.0
Ash (%)	19.8	15.0	9.5
Crude Protein (%)	25.0	17.0	13.2

Dry matter (DM) basis.

The mineral content of kochia was very high at the earliest stage of maturity(prebloom,Table 1) which would reduce the nutritive value of kochia, even though the protein was also highest at the earliest stage of harvest. This reduction in nutritive value is due to the lower proportion of non-ash, or organic matter, from which energy is derived. The proportion of stems in kochia rapidly increased between midbloom and full bloom, indicating a reduction in nutritive value at this time, which was also shown by a decline in protein content. However, waiting until midbloom to harvest greatly increased yield with a lesser decline in feed value compared to the prebloom stage(Table 1).

1.2. These same materials were harvested, ensiled, and fed to wethers (Finley and Sherrod, 1971) to measure nutritive value and intake. Some of the ensiled kochia at the later two stages of harvest was refused by the sheep. The analysis indicated that this was mainly stems. The proportion of material refused increased with increasing stage of maturity, which also corresponded with an increase in the proportion of stems (compare Table 2 with Table 1).

Table 2. Dry matter intake, percent of feed consumed or refused, and composition of consumed and refused ensiled kochia harvested at three stages of maturity (Finley and Sherrod, 1971).

	Prebloom	MIdbloom		Full bloom	
	Consumed	Consumed	Refused	Consumed	Refused
Daily DM intake (g)	794.9	577.9	45.2	514.2	130.6
(%)	100	93	7	80	20
Composition % DM basis:					
Crude protein	24.2	18.2	11.8	15.1	7.5
Ash	20.2	16.5	11.0	13.6	7.1
Crude fibre	17.9	28.5	26.5	30.1	48.6

The digestibilities of the kochia silage decreased with increasing maturity (Table 3).

Table 3. Digestibility of consumed portions of kochia silage harvested at three stages of maturity (Finley and Sherrod, 1971).

	Prebloom	Midbloom	Full bloom
Digestibility DM basis (%)			
Organic matter	71.0	61.8	53.2
Crude protein	81.5	73.9	59.9
Crude fibre	55.3	52.3	37.5
Daily nitrogen balance (g)			
Nitrogen intake	30.83	16.84	12.35
Nitrogen in feces	5.71	4.40	4.93
Nitrogen in urine	23.42	14.78	10.76
Nitrogen retention	1.70	-2.32	-3.34
N retained, % intake	5.5	-13.8	-27.0

Digestibilities of constituents of the kochia as well as nitrogen retention were significantly reduced as the stage of maturity of the kochia increased Table 3).The low nitrogen retention, even with the prebloom kochia which contained high levels of crude protein(Table 3), was a matter for concern. The apparent digestibility coefficient for crude protein was 81.5 (Table 3) for prebloom kochia, suggesting that of the 30.83 g of N intake daily, that 81.5% or 25.13 g were absorbed from the digestive tract- however 23.42 g were excreted in the urine, meaning that only 1.71 g or 6.8%, of absorbed N was retained in the body. This is a very low value. The same rationale can be applied to the more mature stages of Kochia. Such low N retentions are usually associated with disturbances in amino acid utilization which may result from deficiency or imbalance in amino acid supply. Recent observations suggest a severe deficiency of S-containing amino acids in kochia which might have a negative effect on N retention, however a specific effect of such a deficiency on ruminant N retention has not been documented and should be further investigated.

The extremely low N retentions for mid and full bloom kochia result from a relatively constant fecal N excretion which makes up a larger proportion of total excretion as total excretion decreases. Calculation of "True" digestibilities for crude protein show that the values are closer than indicated by the apparent digestibility figures. For example, if the fecal N excretion of metabolic origin (non kochia) was 2 g/day then the "true digestibility" can be calculated as follows:

Prebloom	30.83-(5.71-2)/30.83= 88.0%
Midbloom	16.84-(4.40-2)/16.84= 85.7%
Fullbloom	12.35-(4.93-2)/12.35= 76.3%

In fact, metabolic fecal N excretion increases at higher N levels usually so the digestibility values are actually quite close and means that the partition of N is closer than apparent from casual observation of the data. The question of the poor utilization of absorbed N from kochia is addressed later in this paper.

1.3. In a final study, Sherrod (1973) fed the midbloom kochia, harvested as hay, in various proportions with alfalfa hay, to sheep to determine the effects of diluting the kochia with other feed on digestibility and nitrogen retention. The composition of the kochia and the alfalfa used are shown in Table 4.

Table 4. Composition of kochia and alfalfa hays used by Sherrod,(1973).

	Kochia	Alfalfa
Composition (%DM):		
Crude protein	14. 6	13.9
Ash	14.2	8.3
Crude fibre	25.0	40.0
Acid detergent lignin	3.9	9.9
Nitrate	0.76	0.27

The kochia was slightly higher in crude protein, higher in ash, and lower in both crude fibre and acid detergent lignin than the alfalfa, suggesting higher nutritive value, but also contained a toxic level of nitrate, which could have contributed to the low nitrogen retention.

The effects of diluting kochia with alfalfa in the ration for sheep are shown in Table 5.

Table 5. Effects of mixing kochia hay with alfalfa hay on digestibility and nitrogen retention (Sherrod, 1973).

Kochia (%) Alfalfa (%)	100 0	75 25	50 50	25 75	0 100
Daily DM intake (g)	893.4	915.1	908.9	902.8	896.8
Digestibility (%)					
Organic matter	62.7	61.5	59.0	56.5	54.5
Crude protein	68.9	69.1	70.8	69.6	68.1
Crude fibre	47.7	48.1	47.9	44.4	44.5
Daily nitrogen balance (g)					
N intake	20.81	21.05	20.72	20.40	20.00
N in feces	6.46	6.50	6.05	6.20	6.37
N in urine	12.18	12.63	10.86	10.00	9.45
N retained	2.17	1.92	3.81	4.20	4.18
N retained as % of intake	10.4	9.1	18.4	20.6	20.9

Dilution of the kochia with 50% or more of alfalfa substantially improved nitrogen retention. As the alfalfa increased the urinary excretion of N decreased while the fecal N remained relatively constant, reflecting the relatively constant protein content of the diets. The effect of kochia is therefore to increase urinary N excretion, in terms of N retention, which implies that the protein content of kochia is relatively well digested. The increase in urinary N excretion is consistent with either a specific toxic effect or possibly an amino acid utilization disorder. This implied that, if some factor in kochia was damaging the kidney's ability to retain and utilize protein in kochia, then dilution with alfalfa, a good source of protein for ruminant animals, somehow was ameliorating this effect, provided that kochia was 50% or less of the diet. Alfalfa may also have provided a balance of amino acids permitting more efficient utilization of the N. If one reads chapter 1 of this present report, it is clear that farmers were also practising this rule of keeping the amount of kochia in the diet less than 50%.

2. Studies in Saskatchewan on kochia grown on saline soil.

2.1. Similar beneficial effects of diluting kochia with a grass-alfalfa hay were found in recent studies in Saskatchewan on kochia grown on saline soil (Cohen et al., 1989). In the initial phase of this study, an attempt was made to improve the nitrogen retention of kochia hay by adding calcium carbonate (limestone) to counteract the 2.6% soluble oxalate present in the kochia hay (see Table 6). The hypothesis was that oxalate might be the toxic factor in kochia that was reducing nitrogen retention, since oxalate is known to adversely affect kidney function (Kingsbury, 1964). When kochia was fed at 100% of the diet to steers, the intakes and nitrogen retention was much lower than the control bromegrass-alfalfa hay, regardless of whether the kochia was supplemented with calcium carbonate or not (Table 6).

Table 6. Composition, nitrogen retention and feed intake of kochia, kochia plus calcium carbonate (Ca), and bromegrass-alfalfa hay (Cohen et. al., 1989).

	Brome-alfalfa	Kochia	Kochia+Ca
Composition (% DM)			
Crude protein	12.8	9.1	9.1
Ash	9.6	11.1	13.7
Nitrate	trace	0.5	0.5
Oxalate	0.6	2.6	2.6
Intake, digestibility and nitrogen retention			
OMD (%)			
Total nitrogen	61.3	55.4	55.4
retention (g/day)			
DM intake	79.4	3.4	3.7
(g/kg 0.75/day)	87.8	37.4	23.0

Intake, nitrogen retention and digestibility of the kochia diets was significantly lower than the brome-alfalfa hay diet. The addition of the calcium carbonate did not improve the nitrogen retention, suggesting that oxalate was not the causative factor reducing nitrogen retention in kochia, or that calcium carbonate was not effective in binding soluble oxalate.

Dilution of kochia with brome-alfalfa hay increased both DM intake and N retention (Table 7) when the brome-alfalfa was predominant in the ration.

Table 7. Effects of diluting kochia with brome-alfalfa on digestibility, intake and nitrogen retention (Cohen et al., 1989).

Kochia (%) Brome-alfalfa (%)	60 40	40 60	20 80	0 100
Organic matter digestion (%)	53.6	51.1	50.8	51.8
DM intake $g/kg^{0.75}/day$	76.6	74.2	88.8	84.8
Percent of feed nitrogen retention	36	36	49	53
Percent of feed nitrogen in urine	26	26	16	15

Attempts to increase the percent of kochia in the diet above 60% led to rapid declines in intake. The feed intake at 80% kochia in the mixture was only 69% of the intake at 60% kochia in the diet. At 100% kochia the feed intake was reduced to 25% of the value at 60 % of the diet. These results were different to those of Sherrod (see Table 5) where feeding sheep rations containing more than 50% kochia hay of midbloom stage of maturity did not result in a decline in intake.

At 20% kochia there was little negative effect on nitrogen retention, but by 40% the nitrogen retention was reduced significantly (Table 7). The reduced N retention was matched by an increase in urinary excretion of nitrogen. These effects were similar to the results obtained by Sherrod (see Table 5) except that

Sherrod did not see a decline in nitrogen retention until the kochia percentage was higher than 50%. The kochia used by Cohen et al., (1989) had a lower crude protein content than that used by Sherrod (9.1% compared to 14.6%). In experiments feeding 100% kochia silage of three different stages of maturities to sheep, Sherrod(1971) found that nitrogen retention as a percent of intake was much less in full bloom kochia of 15.1% protein than in prebloom kochia of 24.2% protein (see Table 2). Thus it was possible that increasing the protein content of kochia (for example by harvesting at an earlier stage of maturity) would allow for higher percentages of kochia in hay mixtures before serious negative effects on nitrogen retention occurred. The large reduction in feed intake observed in Cohen's experiments when kochia was more than 60% of the ration might be related to the low protein content of the kochia fed; this, coupled with the reduction in nitrogen retention, could lead to a physiological reduction in feed intake. If so, then feeding a kochia hay of higher crude protein might delay reduction in feed intake to a higher proportion of kochia in the diet, such as observed in the experiments of Sherrod with sheep. There may also be differences between cattle and sheep: sheep might be able to achieve higher nitrogen retentions at a particular level of kochia in the diet.

A final factor to be considered is whether kochia is being fed to mature animals as part of a maintenance ration or whether it is being fed to young animals as part of a growing ration. In feedlot experiments in New Mexico, Kiesling et al., (1986) found that steers had much lower rates of gain on a 50% kochia diet than on a 50% alfalfa diet (other ration components mainly grain).

Table 8. Composition, digestibilities, and nutrient intakes of kochia cut at full bloom and early seed stages of maturity. Comparison with good quality alfalfa (Knipfel et al., 1989).

	Kochia		Alfalfa
	Full bloom	Early seed	Early bloom
Composition (%DM)			
Crude protein	10.5	6.4	17.3
Ash	13.2	9.4	11.4
Cellulose	30.7	34.9	31.4
In vitro organic matter digestibility	57.3	48.7	62.0
Nutrient digestibility (live animal)(%)			
Organic matter	61.7	50.5	-
Crude protein	61.1	50.5	-
Cellulose	57.8	48.7	-
Energy	60.9	49.1	-
Digestible energy (MJ/kg)	10.12	8.40	10.29
Digestible nutrient intakes (g/kg$^{0.75}$)			
Organic matter	31.6	23.2	32.9
Crude protein	4.22	1.41	8.1
Cellulose	10.4	5.7	9.7
Energy (kJ/kg$^{0.75}$)	601	431	629

Nutrient digestibilities, digestible energy, and nutrient intakes were all significantly different between the two stages of maturity of the kochia. Eventhough the first kochia was cut rather late (full bloom), it still had digestibility

Kochia had a metabolizable energy value for maintenance (MEm) which was 83% of the MEm value for alfalfa, but the metabolizable energy value for gain (MEg) of kochia was only 57% of the MEg value of alfalfa. Thus kochia might be expected to be more valuable as part of the maintenance ration for beef cows (particularly if kept at less than 40-50% of the ration) rather than as a major component of a growing ration. This is also suggested by the poor utilization of protein from kochia. In the two surveys of farmers using kochia (Cohen et al., 1989, Hanson, 1988, Hanson, Chapter 1 of this report), the vast majority of farmers were feeding kochia to pregnant beef cows, and they were feeding less than 50 % of the ration as kochia.

2.2. Kochia was harvested at two stages of maturity, full bloom and early seed, and fed to wether lambs (35-50kg) as 100% of the ration, to measure digestibilities and feed intake (Knipfel et al., 1989). This study was done before the negative effects of high percentages of kochia in the diet were known (Cohen et al., 1989). The site of collection of the kochia was a saline depression, and wet conditions early in the growing season prevented collection as early as was desired. Therefore, the kochia was harvested at full bloom, which was known from Sherrod's studies (see Table 1 and 2) to be later than the best nutritive value stage for kochia. Nonetheless, the material cut at full bloom was superior to the material cut at early seed formation stage (Table 8).

close to that of alfalfa. However, nitrogen retention was not measured. For kochia fed at 100%, the nitrogen retention of the kochia would be expected to be much less than the alfalfa. Even though the kochia was fed as 100% of the diet, the feed intakes were as good for the higher quality (full bloom) kochia as for the alfalfa. No decline in intake with 100% kochia was observed as had been found by Cohen et al., (1989) in steer trials (see earlier discussion).

The apparent inconsistencies in data from these different studies suggested that there may be differences in kochia acceptability by sheep and cattle due to changes in various components of the kochia with maturity stage.

The Present

This study was designed to measure the nutritive value of kochia cut at three stages, using both wethers and steers. In a previous study of the in vitro nutritive value of kochia (Coxworth et al., 1988) kochia reached maximum yield of digestible nutrients at the late bud or early flower stage of maturity, similar to the results of Sherrod described earlier (see Table 1 and 2). Therefore, in the present study it was decided to collect kochia at late bud (called preprime in this report), early flower (called prime in this study), and late flower-early seed (called mature in this report). The kochia was to be grown on saline soil.

As the study progressed, several unexpected difficulties resulted in changes to the original plan. Insufficient kochia was harvestable at one site for both the sheep and cattle studies, thus the prime kochia was collected at a different location to the preprime and the mature kochia. Direct comparisons of the effect of maturity at one site were therefore lost,and this difficulty must be considered in interpretation of results. Difficulties in harvesting and/or handling and grinding the kochia for the cattle studies led to a greater loss of nutrients compared to the kochia fed to the sheep. The composition of the material fed to the cattle are suggestive of loss of leaf, i.e., the material had low protein and high fibre compared to the material fed to the sheep. Some of the data from the steer trial are included in the results, but we believe they are not representative of the quality of the materials as standing in the field. They may be indicative of the effects of leaf loss on feed value. The sheep study results are believed to be much more representative of the three stages of maturity of the kochia. Initially, attempts were made to feed the kochias at 100% of diet to simplify digestibility determinations, however neither wethers nor steers would consume the preprime or prime cuts of kochia. The mature cut was consumed at an acceptable level. The decision was made to feed the most mature kochia at 100% of the ration to test whether increased maturity would reduce the factors causing poor intake of kochia feed at high percentages in the diet, and to feed the earlier cuts at 50% of the ration with the balance of the ration consisting of Altai wild ryegrass hay (wethers), or a mixed grass hay(steers). This meant that it was not possible to compare the effects of maturity at the same level of kochia in the diet since the preprime and prime materials were fed as 50% of the ration in combination with Altai wild rye hay or mixed hay, and that digestibility data for both mixed rations and partial digestibility of hay and kochia had to be calculated.

2.0 MATERIALS AND METHODS

The preprime and mature kochia materials were harvested at the Vance salinity site near Swift Current, Sask. The preprime sample was harvested on August 4th, 1989, when the the plants were a mixture of late bud and full flower stages of maturity. The mature plants were harvested on September 14th, when the plants were at the early seed stage but the leaves were still green. The prime kochia was cut at the Smith salinity site near Swift Current when the plants were at the midflower stage of maturity on July 28th (90% flowering). Due to weather the preprime and prime kochia were cut about two weeks (preprime) and one week (prime) later than planned, and thus may be lower in feed quality than intended. The kochia was cut with a haybine which crimps the stems to aid in drying. In spite of the crimping the kochia remained in the field for several weeks before it was dry enough to bale and this delay in harvest may have resulted in considerable loss of leaf at baling. The hay was baled in small rectangular bales. The bales were stored outside until the beginning of the sheep trial in January, 1990 and the beginning of the cattle trial in March, 1990.

The bales for the sheep trial were ground in a mix mill through a 5 cm screen and mixed 50:50 with Altai wild rye hay, also similarly ground. The kochia and mixed grass hay for the cattle (steers) trial were ground through a forage harvester and stems were estimated to have an average length of 7-10 cm. It is believed that this is the stage where the kochia may have lost leaf material since the forage harvester did not have a collection system below the pickup. Kochia hay appears to have severe difficulties associated with its harvesting and processing which need to be further studied. There may be overwhelming rationale to store kochia as silage to reduce leaf loss as well as to eliminate the excessively long curing period for hay. The mature kochia was ground similarly to the prime and preprime materials, but was not mixed with hay for feeding.

The three cuts of kochia (preprime and prime fed as 50:50 mixtures with Altai wild rye hay) were fed to four wether lambs, with initial body weights ranging from 32-49 kg (average 37 kg), in a randomized block design, at the Swift Current Research Station of Agriculture Canada. Following a 28-d adaptation period, each wether was fed the diet for a 14-d period to assess feed intake, following which a 5-d total fecal collection was undertaken, with feed intake maintained at the voluntary intake level established during the intake assessment period. Total fecal collections were thoroughly mixed and 10% taken for analysis. Daily samples of feed were composited, dried, and ground.

Feeds and feces were analyzed for dry matter (DM), organic matter (OM), and crude protein (CP) by the Association of Analytical Chemists (AOAC 1984) methods (procedure numbers 7.003, 7.009, and 7.015, respectively), cellulose by the Crampton and Maynard (1938) procedure, and acid detergent fibre (ADF) and neutral detergent fibre (NDF) by the procedures of Goering and Van Soest (1970). The procedure of Troelsen (1971) was used to determine in vitro digestibilities of OM. The digestibility and intake data were statistically analyzed by the procedure for randomized block designs (Steel and Torrie, 1960) and reported on a dry matter basis. Because of the difference in location of collection of the three kochia samples, difficulties in harvesting and diet preparation,and the fact that the first two cuts were fed at 50 % of the ration and the mature kochia at 100% of the ration, only general observations about the effect of stage of maturity on the feed value were made.

The trials with steers followed similar procedures to the sheep trials. The poor quality of the kochia hay fed to the steers compared to the material fed to the sheep prevents direct comparison of sheep and cattle results.

3.0 RESULTS

The compositions of the kochia diets fed to the cattle and sheep are shown in Table 9. Kochia diets fed to the steers had substantially lower crude protein contents and higher fibre contents than the same materials fed to the sheep. This poor quality was reflected in the measurements of nutrient digestibility and intake by the steers.

The preprime kochia, although it was cut at an early stage of maturity than the prime cut, had lower crude protein content. One possible explanation is that the Smith site, where the prime material was grown, had higher soil fertility, leading to higher crude protein content. Other explanations include the delays in harvest and storage of the kochia caused by rain and delayed curing.

The higher protein content of the prime cut compared to the preprime cut was also reflected in the higher protein content of the prime kochia diet fed to the sheep (Table 10). The mature kochia diet (not diluted with AWR) was much poorer in nutritive value, as reflected in the low protein content and the higher ADF, NDF and lignin(Table 10).

Table 9. Composition of kochia and AWR fed to steers and wethers.

	OM	Ash	N	CP	ADF	NDF	Cell	Hemicell	Lignin	P
	% DM									
Steers										
Preprime kochia[1]	89.3	10.7	1.08	6.8	39.3	55.6	30.0	16.3	9.3	.13
Prime kochia[2]	90.7	9.3	0.87	5.4	39.9	57.5	30.1	17.6	9.8	.24
Mature kochia[1]	95.3	4.7	0.73	4.5	54.4	73.0	37.4	18.6	17.0	.11
Mixed hay	93.1	6.9	1.32	8.3	49.1	61.6	39.2	12.5	9.9	.07
Wethers										
Preprime kochia[1]	89.8	10.2	1.75	10.9	30.3	49.0	25.8	18.7	4.5	.27
Prime kochia[2]	86.2	13.8	2.05	12.8	34.5	50.0	27.4	15.5	7.1	.27
Mature kochia[1]	92.4	7.6	1.11	6.9	44.8	65.4	31.1	21.6	12.7	.17
AWR	93.0	7.0	1.59	9.9	39.9	69.0	34.4	29.1	5.5	.09

[1] Site one (Vance)
[2] Site two (Smith)

Table 10. Composition of kochia containing diets when fed to wethers.

	Organic Matter	N	CP	ADF	NDF	Cellu-lose	Hemi Cellulose	Lignin	P
	% DM								
Diet 1									
50% Preprime kochia[1] 50% AWR	91.4	1.67	10.4	35.1	58.9	30.1	23.8	5.0	0.18
Diet 2									
50% Prime kochia[2] 50% AWR	89.6	1.82	11.4	37.2	59.9	30.8	22.7	6.4	0.18
Diet 3									
Mature kochia[1]	92.7	1.11	6.9	43.8	65.4	31.1	21.6	12.7	0.17

[1] Site one (Vance)
[2] Site two (Smith)

The digestible nutrient coefficients of the kochia containing diets are shown in Table 11. These coefficients measure the percentage digestibility of the various nutrients in the diets. The prime kochia containing diet had the highest feed value, followed by the preprime. The mature kochia diet suffered in comparison because of the poor feed value of the kochia at this stage of maturity and the fact that it was not diluted by good quality AWR hay as were the other two kochia diets.

Table 11. Digestibility coefficients of nutrients in kochia: AWR diets fed to sheep.

Digestibility of	Pre Prime	Prime	Mature	$S\bar{x}$
		-% DM-		
OM	56.8	56.5	54.0	2.8
N	55.8^a	62.7^a	37.9^b	8.0
E	51.0	51.1	47.8	3.3
Cell	59.4	59.6	58.4	3.5
NDF	55.0	54.9	56.5	3.4
ADF	48.9	51.0	52.2	4.4

$^{a, b}$ Significantly different within a row by Duncan's NMRT.

The content of digestible nutrients in the various diets fed is shown in Table 12. The preprime and prime kochia diets had significantly higher protein contents than the mature kochia.

Table 12. Digestible nutrient contents of nutrients in kochia: AWR diets to sheep.

Content of Digestible		Pre Prime	Prime	Mature	$S\bar{x}$
OM	(g/100 g DM)	50.9	50.5	47.3	2.7
N	(g/100 g DM)	0.93^a	1.14^a	0.42^b	0.12
E	(kcal/ g DM)	2.13	2.08	1.98	0.14
Cell	(g/100 g DM)	18.0	18.3	18.2	1.2
NDF	(g/100 g DM)	32.6	32.9	36.9	2.3
ADF	(g/100 g DM)	17.3^b	18.9^b	22.8^a	1.8

$^{a, b}$ Numbers in a row with different letters are significantly different from each other by Duncan's NMRT.

The intakes of digestible nutrients are shown in Table 13. The intake of digestible organic matter was highest in the mature kochia diet, while the intake of digestible protein was highest in the prime kochia diet. In this trial, the sheep did not have reduced intakes on the 100% kochia ration (the mature kochia), in contrast to the results with steers reported by Cohen et al., (1989). Sherrod (see Table 5) also did not observe a reduction in intake by sheep when they consumed a 100% kochia ration compared to 100% alfalfa.

Table 13. Digestible nutrient intakes by sheep fed kochia: AWR diets.

Intake/kg$^{0.75}$		Pre Prime	Prime	Mature	$S\bar{x}$
OM	(g)	25.9^{ab}	24.9^{b}	28.1^{a}	1.5
N	(g)	0.46^{b}	0.56^{a}	0.23^{c}	0.03
E	(kcal)	106.1	102.0	111.0	5.8
Cell	(g)	9.0	9.0	10.2	0.7
NDF	(g)	16.2^{b}	16.1^{b}	20.8^{a}	1.3
ADF	(g)	8.6^{b}	9.3^{b}	12.8^{a}	0.8
CP	(g) (calc'd)	2.88	3.50	1.44	ND

[a, b] Significantly different (in a row) by Duncan's NMRT.

The partial digestibilities of the kochia and AWR components of the diets are shown in Table 14. Also shown are nutrient contents and the intake of nutrients per material fed. The prime kochia had the highest digestibility and intake of crude protein of the three maturities of kochia fed. The stage of maturity of the kochia had little effect on the intake of digestible organic matter between the three stages of maturity of the kochia. However,the prime kochia would be the choice because of its higher content of digestible protein and the higher intake of digestible protein of this material.

Table 14. Partial digestibilities of kochia in mixtures with hay fed to sheep

		Pre Prime	Prime	Mature	AWR
Digestibility Coefficients:					
OM	(%DM)	52.9	52.3	54.0	60.7
N	(%DM)	47.7	61.5	37.9	63.9
Cellulose	(%DM)	53.6	54.0	58.4	65.2
NDF	(%DM)	46.5	46.3	56.5	63.5
ADF	(%DM)	40.0	44.2	52.2	57.8
Energy	(%DM)	44.6	44.8	47.8	57.4
Nutrient Contents:					
OM	(g/100g DM)	49.2	48.4	47.3	52.6
N	(g/100g DM)	0.85	1.27	0.42	1.01
Cellulose	(g/100g DM)	13.6	14.2	18.2	22.4
NDF	(g/100g DM)	21.4	24.0	36.9	43.8
ADF	(g/100g DM)	11.6	14.8	22.8	23.0
Energy	(kcal/g DM)	1.78	1.68	1.98	2.48
Digestible Nutrient Intakes (/$kg^{0.75}$):					
OM	(g)	28.5	26.5	28.1	23.3
N	(g)	0.50	0.70	0.24	0.42
Cellulose	(g)	8.7	8.7	10.2	9.3
NDF	(g)	14.3	14.2	20.8	18.1
ADF	(g)	7.7	9.1	12.8	9.5
Energy	(kcal)	110.1	101.9	110.9	102.1

It should be emphasized that these trials did not measure nitrogen retention. Sherrod's experiments (see Tables 3 and 5) indicate that kochia with the highest crude protein had the best nitrogen retention (Table 3) and diluting kochia with at least 50% alfalfa (Table 5) increased nitrogen retention considerably. These sort of experiments need to be repeated here both with cattle and sheep to confirm these results locally.

Only some of the results of the steer trials are included, since it was clear from Table 9 (q.v.) that the kochia materials fed to the steers were much poorer in quality (lower in protein particularly) than the materials fed to the sheep. Table 15 shows the partial digestibilities of all the kochia forages fed, with a comparison with the mixed hay used to dilute the preprime and prime kochia diets. Comparison of Table 15 with Table 14 (same experiments with sheep) reveals that the kochia materials fed to the steers were much poorer in quality than the supposedly similar materials fed to the sheep, and should not be considered representative of kochia hays cut at the three stages of maturity.

Table 15. Partial digestibilities of kochia in mixture with hay fed to steers. Comparison to the AWR hay used in the mixtures.

		Kochia			AWR
		Preprime	Prime	Mature	Hay
Digestibility coefficient:					
OM	(% DM)	47.3	54.9	43.0	61.5
N	(% DM)	-1.3	-14.9	-109.5	37.1
Cellulose	(% DM)	61.2	61.2	60.1	72.8
NDF	(% DM)	51.5	55.7	53.6	65.5
ADF	(% DM)	50.2	53.0	52.5	71.2
Energy	(% DM)	41.5	49.5	36.5	56.5
Nutrient contents of:					
OM	(g/100 g DM)	35.9	46.3	34.2	53.1
N*		ND	ND	ND	0.49
Cellulose	(g/100 g DM)	17.5	17.5	21.7	28.5
NDF	(g/100 g DM)	27.6	31.6	38.6	40.4
ADF	(g/100 g DM)	18.6	20.2	28.0	34.8
Energy	(k cal/g DM)	1.64	1.98	1.58	2.40
Digestible nutrient intakes (/kg$^{0.75}$)					
OM	(g)	17.6	33.4	19.1	52.4
N*		ND	ND	ND	-
Cellulose	(g)	5.6	10.4	10.1	26.0
NDF	(g)	9.6	20.2	17.9	37.0
ADF	(g)	5.3	11.8	13.0	31.8
Energy	(k cal)	129.0	58.4	73.4	219.6

* Not calculated due to negative digestibility data.

4.0 CONCLUSIONS AND RECOMMENDATIONS

An additional series of experiments could be planned in the future, based on what is now known on the production and feeding of kochia hay to cattle and sheep.

The first stage should be the production of kochia hay on a saline gradient site representative of farmers' situations. Nitrogen and phosphorous fertilizer could be applied to ensure good yields and good levels of crude protein in the kochia produced. The kochia would be harvested at three stages of maturity representing early bud, late bud-early flower, and full flower, shown from previous studies to produce the quality of forage desired to be tested.

Cutting and crimping, baling, and grinding and mixing would need to be carefully monitored to ensure the least loss of leaf fraction possible. Alternative harvesting methods should also be studied. The kochia hays should be fed in combination with other hays and/or supplemental nutrient sources to determine potential ration combinations which would be efficacious.

The feeding trial would measure digestibility, intake and nitrogen retention, and in addition should investigate the possibility of improving N retention through S- amino acid supplementation*. Additional studies may be required to determine the exact cause(s) of the low N retention and poor feed intake.

Once the best stage of maturity of kochia had been established with sheep, then a similar trial could be run with cattle (preferably pregnant beef cows) to compare digestibilities, intakes and nitrogen retentions with the sheep results, but now using the class of animal (pregnant beef cows) most likely to be fed kochia hay.

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* E.g., methionine available commercially at reasonable cost.

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Chapter 10

STUDIES ON THE EFFECTS OF STAGE OF MATURITY ON THE FEED VALUE AND TOXINS CONTENT OF KOCHIA AT TWO LOCATIONS

E. Coxworth

1.0 INTRODUCTION

Many farmers in Saskatchewan and elsewhere have successfully used kochia as a feed for cattle (Hanson, 1988, Hanson, chapter 1 of this report) provided certain precautions were taken (Coxworth et. al., 1988). These precautions included: not feeding more than 50% of the ration as kochia, feeding kochia only to beef cows for winter maintenance rations, i. e., not using kochia in growing rations, and analyzing kochia for oxalate and nitrate, two potentially toxic components of kochia (Kingsbury, 1964).

There have been reports from the USA and Argentina of toxicity problems with cattle eating kochia (Dickie and James, 1983, Karachi et. al., 1986, 1988, Kiesling et. al., 1985, Souto and Milano, 1966). These toxicity problems were related to saponin by Souto and Milano (1966). Later studies in New Mexico by Kiesling et. al., (1985) and Karachi et. al., (1986) indicated that saponin was not likely to be the problem, but found that alkaloids seemed to be implicated as the source of toxicity. A low alkaloid content lines of kochia was selected based on a colorimetric test for alkaloids. Feeding trials with rats confirmed that this low alkaloid line of kochia was less toxic (Smith et. al., 1986).

Feeding trials in Saskatchewan with steers (Cohen et. al., 1989) showed that retention of nitrogen was reduced when kochia reached 40% of the diet or more, and the amount of N retention was inversely proportional to the kochia content. Cohen et. al., (1989) suggested that some toxin was present in kochia that was likely affecting kidney function, particularly when kochia constituted more than 40-60% of the diet, and most acutely when kochia was used in production rations, where the animals need for protein was the greatest.

Hinks et. al., (1990) found that kochia was quite toxic to grasshoppers. Other studies showed that kochia contained a feeding deterrent to grasshoppers, so that little damage was done to kochia even when local populations of grasshoppers were very high (Olfert et. al., 1990). Hinks suggested that breeding attempts to remove toxic factors in kochia to cattle should try not to remove the toxins and feeding deterrents to grasshoppers, since kochia's resistance to grasshopper damage was a major advantage to it as a forage for semi-arid areas.

We discovered that Drs. Byron Beck and Roy Smith of the Toxicology Laboratory, Alberta Agriculture, Edmonton,Alberta, had found two alkaloids in kochia: acetyltryptamine and p-methoxyphenethylamine (Smith, 1989). They had developed procedures to quantitatively measure the amounts of these materials in kochia. Arrangements were made to have them measure the amounts of p-methoxyphenethylamine, the substance considered to be most toxic, in the three kochia samples fed to the sheep in the animal studies at Swift Current (see chapter 9).

In addition to the study at Swift Current on the effect of maturity on feed value, a similar study was conducted at Saskatoon. The site used was one where high yields of kochia had been obtained several years in a row. Since farmers had reported that a major problem with kochia was that it gradually reduced in yield and vigour if it was grown year after year at the same site (see chapter 1 of this report), we considered it important to attempt to discover why this Saskatoon site was capable of producing good kochia yields year after year.

One stage of maturity harvested at Saskatoon was that of mature seed (plants brown, but leaves still present). Farmers reported that kochia often contaminated crops grown on saline soils. When the crop was harvested by combine, much of the kochia seed and leaves were discharged in the chaff fraction from the combine. Farmers asked for information about the feed value of kochia seed and chaff and the effect this would have on the cereal chaff fraction (Hanson, 1988). Farmers noted that by collecting kochia seed in the chaff, they could likely reduce the population of kochia seedlings in the fields the following year.

2.0 MATERIALS AND METHODS

The collection of the three cuts of kochia for the digestibility and intake trial at Swift Current has been described in chapter 9. Two sets of samples were obtained by staff at Swift Current and sent to SRC for analyses for alkaloid, oxalate and nitrate.

The samples were sent to the Toxicology Laboratory of Alberta Agriculture for analysis for p-methoxyphenethylamine. There the samples (10 g) were basified with sodium hydroxide and extracted with chloroform. The combined chloroform extracts were extracted with dilute sulphuric acid to remove bases, including the p-methoxyphenethylamine. The combined acidic aqueous extracts were extracted with petroleum ether and then basified with sodium hydroxide. The basic extracts were again extracted with chloroform. The combined chloroform extracts were carefully dried to remove all traces of water. The chloroform was removed by evaporation. Several drops of acetic anhydride were added to the residue, which was then heated to convert the bases to the acetate derivatives. The derivatives were quantitatively analyzed by gas-liquid chromatography (GLC). The identity of the p-methoxyphenethylamine was originally confirmed by GC-mass spectrophotometry.

Oxalate was measured by the method of Dye (1956) for soluble oxalate. Nitrate was analyzed at the Feed Testing Laboratory of the University of Saskatchewan. Protein, ash and in vitro organic matter digestibility (IVOMD) were measured by the same procedures described in chapter 9.

Kochia was harvested in Saskatoon for the stage of maturity study at the Co-op Feed Mill site on Jessop Avenue. Kochia was collected in 1986, 1987 and 1988. The samples were collected in the area to the southeast of the mill where kochia was growing vigorously (50-100 m southeast of the mill). Samples were collected randomly in the areas where kochia was growing vigorously and uniformly.

The area was used by the feed mill to dump waste feed. Each fall the mature kochia plants were bulldozed off the site in a manner which disturbed the top 5-10 cm (est.) of soil.

In 1986, six replicates (1 m^2 each) of kochia plants were harvested on 5

August and 18 August. In 1987, six replicates were harvested on 29 July and 14 August. In 1988 five replicates kochia were harvested on 26 July (full flower), 23 August (late flower, early seed), and 29 September (mature seed, plants brown but leaves still adhering). Plants were air dried, and subsamples oven dried at 30-35°C in an air circulating oven overnight. In 1988, subsamples were separated into leaves, stems and (where present) seed. The seed was cleaned of calyx and some of the pericarp by rubbing on screens. The chaff from seed cleaning was added to the leaf fraction. For analyses, materials were ground through a hammermill to pass a 1.25 cm screen. Subsamples were then ground though a Wiley mill to pass a 1 mm screen. Ground samples were passed though a revolving tube sampler to ensure random samples for analysis.

Four random soil samples were taken (by Z. Abouguendia and R. Godwin) on 13 July, 1988, after kochia had started vigorous growth when rains commenced at the end of June. Soil samples were analyzed for pH, salinity, and available concentrations of nitrogen, phosphorous and potassium by the Soil Testing Laboratory of the University of Saskatchewan.

3.0 RESULTS AND DISCUSSION

The analyses of the two sets of samples of the stage of maturity study at Swift Current are shown in Table 1.

Table 1. Analyses of kochia samples used in the three stages of maturity study at Swift Current.

Harvest date	Title	Ash	CP	IVOMD	Oxalate	Nitrate	Alkaloid
		% DM					
1st samples							
28 July	Prime	16.4	13.3		3.66	trace	0.0
4 August	Preprime	14.1	10.3	53.8	2.89	0.0	0.1
14 September	Mature	10.9	7.8	49.8	1.88	0.0	0.0
2nd samples							
28 July	Prime	ND	ND	ND	4.26	0.0	0.1
4 August	Preprime	ND	ND	ND	1.68	0.0	0.2
14 September	Mature	ND	ND	ND	0.70	0.0	0.03
Material fed to the sheep							
28 July	Prime	13.8	12.8				
4 August	Preprime	10.2	12.8				
14 September	Mature	7.6	6.9				

Note: alkaloid reported in mg%.

The results in Table 1 show considerable variations between batches of samples. In all cases the levels of alkaloids were low, although the significance of the levels would depend on the toxicity of the alkaloids in cattle, which have not been established. However, Dr. Roy Smith reported recently (Smith, 1991) that feeding rats standard rat diets,in which the levels of p-methoxyphenethylamine found in kochia were added, did not cause toxicity. On the other hand, feeding rats kochia containing diets caused a gradual starvation. When the amino acid analysis of kochia forage was carried out, the levels of methionine and cystine were found to be very low (0.1% and 0.03% respectively, as %N of total kochia %N). These levels should be compared with the levels of methionine of 1.8% and of cystine of 1.4% in alfalfa protein (Butler and Bailey, 1973). While the kochia fed to the rats contained 16% protein, 1.9% oxalate, 2.5% nitrate, 1.1% chloride, and 3.5% sulphate, the main symptoms in the rats were of protein deficiency, suggesting that the very low levels of methionine and cystine were a major factor in the kochia toxicity to the rats. Dr. Smith was of the opinion that future sheep and cattle trials should test supplementing kochia diets with sulphur amino acids such as methionine and cystine (which are cheap to buy) to test whether this supplementation would reduce the poor nitrogen retention found in diets containing 40% or more kochia. In theory, ruminant animals should be able to synthesize sulphur amino acids in the rumen from sulphate, which is abundant in kochia. However, if some factor in kochia inhibits synthesis of sulphur amino acids, then supplementation could have a beneficial effect.

Stage of maturity study at Saskatoon

The yields of kochia obtained in the three years at Saskatoon are shown in Table 2. We remind the reader that the yields at this site are likely unusually high because of its use to dump waste feed. The relative yields between sampling dates and years are of interest however.

Table 2. Yields at the Co-op site in Saskatoon over three years and at different sampling dates.

Year	Sampling date	Stage of maturity	Yield kg/ha DM
1986	5 August	ND	5760
	18 August	ND	9790
1987	29 July	ND	8350
	14 August	ND	9980
1988	26 July	Full flower	9270
	23 August	Late flower, early seed	15110
	29 September	Mature seed	13132

The proportions of leaves,stems and seed were determined for the material harvested in 1988 (Table 3).

Table 3. Proportions of leaf,stem and seed for kochia harvested in 1988.

Harvest date	Yield kg/ha	Height cm	Density stems/m	Plant Components		
				Leaves	Stems --%DM--	Seed
26 July	9270	169	73	47	53	0
23 August	15110	180	86	49	51	0
29 Sept.	13130	140	167	35	52	13

The proportion of leaf changed very little between 26 July and 23 August. During this period, rainfall was above normal, and it is possible that kochia plants were able to do considerable vegetative growth in this period.

The nutritive value of the kochia harvested at the three stages of maturity is shown in Table 4.

Leaves contained high amounts of protein, ash and digestible organic matter. Their composition did not change much with increasing maturity, although there was a decline in nitrate content. Stems were very low in digestible organic matter at all stages of maturity. They were the main factor in lowering kochia hay digestibility. Thus if breeding efforts could be directed towards increased leafiness, there would be an increase in digestibility and protein content. The seed of kochia was high in protein. The seed and leaf material from the mature kochia would constitute the chaff material which would be collected with cereal chaff if a mixed crop of cereal (e.g., barley) and kochia were grown on saline soil. The analysis in table 4 would indicate that this kochia chaff would increase the feed value of cereal chaff which would be expected to range about 4-7% protein and 40-50% IVOMD (e.g., Rutherford and Gimby, 1991). The feed value for ruminant animals of the kochia seed would depend on whether it was digested in the rumen. Several farmers have reported that they were feeding about 10% of the ration as kochia seed to beef cows (Hanson, 1988) or sheep (Slinkard, 1988). No problems or poor feed performance were noted.

Table 4. Nutritive value of kochia from the Co-op feed mill site in 1988.

Sample	Date	% CP (dm)		% Ash (dm)		% IVOMD		% Nitrate		% Leaves	% Stems
		Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.		
1st. Cut W.P.	July 26	16.04	0.81	13.85	0.88	49.72	1.86	1.28	0.33	47	53
Leaf	July 26	25.15	0.72	18.40	0.68	74.54	0.87	1.10	0.38		
Stem	July 26	8.68	0.65	9.77	1.01	30.26	1.86	1.28	0.44		
2nd. Cut W.P.	August 23	14.38	0.48	12.12	0.57	46.92	3.16	0.87	0.12	49	51
Leav	August 23	23.10	0.42	16.92	0.53	69.71	1.32	0.89	0.14		
Stem	August 23	7.01	0.44	7.19	0.79	25.22	2.11	0.88	0.17		
3rd. Cut W.P.	Sept. 29	10.95	1.26	10.92	0.82	43.09	3.01	0.61	0.16	40	60
Leaf	Sept. 29	19.10	1.72	16.88	1.94	70.91	0.59	0.56	0.31		
Stem	Sept. 29	5.95	0.43	6.01	1.07	26.54	3.38	0.33	0.27		
Seed	Sept. 29	28.11	0.85								

W.P. = Whole plant hay (3rd cut: seeds removed).
CP = Crude protein, IVOMD = in vitro organic matter digestibility.
Stage of maturity:
1st cut, July 26, full flowering (copious pollen).
2nd cut, Aug. 23, late flowering, early seed production, leaves still green.
3rd cut, Sept. 29, mature seed, leaves brown but still not fallen from the plant.

The soil analysis of the Co-op site indicated that the pH was 7.5, the salinity about 4 mS/cm, the sodium absorption ratio about 3, and the level of soil fertility: 130 kg N/ha, 115 P/ha, and 616 K/ha. Since the soil analysis was taken in mid-July after rapid growth of kochia had commenced, it indicates that the site had very high soil fertility. We believe that the history of this site, and the soil analysis, suggests that kochia can be grown for at least three years in a row with high yields, provided that much of the crop residue is removed (as would be done if the plants were harvested for hay), the soil is disturbed each year (see Coxworth et. al., 1988), and soil fertility is maintained at a high level.

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Chapter 11

TECHNOLOGY TRANSFER

Field Days Held in 1989

1. Swift Current, August 17, 1989

Approximately 25 people attended this field day held at the Vance farm salinity site about 10 km north of Swift Current. The local TV station filmed the site and the field day, and interviewed several people, including farmers growing and feeding kochia.

The site was well signed, with prominent recognition of funding provided by the Agriculture Development Fund.

Results of experiments conducted at the site during the severe drought of 1988 were handed out at the field day and compared with the experiments underway in 1989.

The results shown in Tables 1-3, and Figures 1 and 2, indicated that kochia yielded very well on this saline site in 1988, in spite of the early season hot dry weather in April, May and June. Rainfall was above normal in July and August and the kochia grew very rapidly once the rain started to come.

In 1988 the best yields of kochia were obtained from early spring cultivation, fertilization and seeding. In 1988 Texas and Saskatchewan kochia had about the same yield, although the Texas kochia used more water.

Kochia responded very well to nitrogen fertilizer in 1988 (Table 3 and Figure 1) with yields of up to 10 tonnes per hectare (4.46 tons per acre) being achieved with a high application rate (150 kg/ha) of nitrogen fertilizer. The best economic return to fertilizer costs was obtained at 100 kg N/ha (Figure 2).

Handed out at the field day, August 17, 1989 Swift Current

Table 1. Vance Site water use 1988 data summary.

Crop	Yield kg/ha	MM Water used	kg/ha/mm
Barley	3285	32.7	100
SK Kochia	9796	96.5	101
Texas Kochia	9664	68.3	142

Table 2. Vance Site methods of established kochia (1988 data summary).

Treatment	Yield (kg/ha)
1. Fall cultivated, naturally seeded, spring fertilized	6180
2. Fall cultivated, fall fertilized and fall seeded	6470
3. Early spring cultivation, fertilized and seeded	7520
4. Late spring cultivation, fertilized and seeded	5370

Table 3. Vance Site fertility results 1988.

Treatment	Yield (kg/ha)
N Fertilizer Applied (kg N/ha)	
0 N	8065
50 N	8065
100 N	9730
150 N	10145

Figure 1. Yield of kochia at various nitrogen fertilizer rates

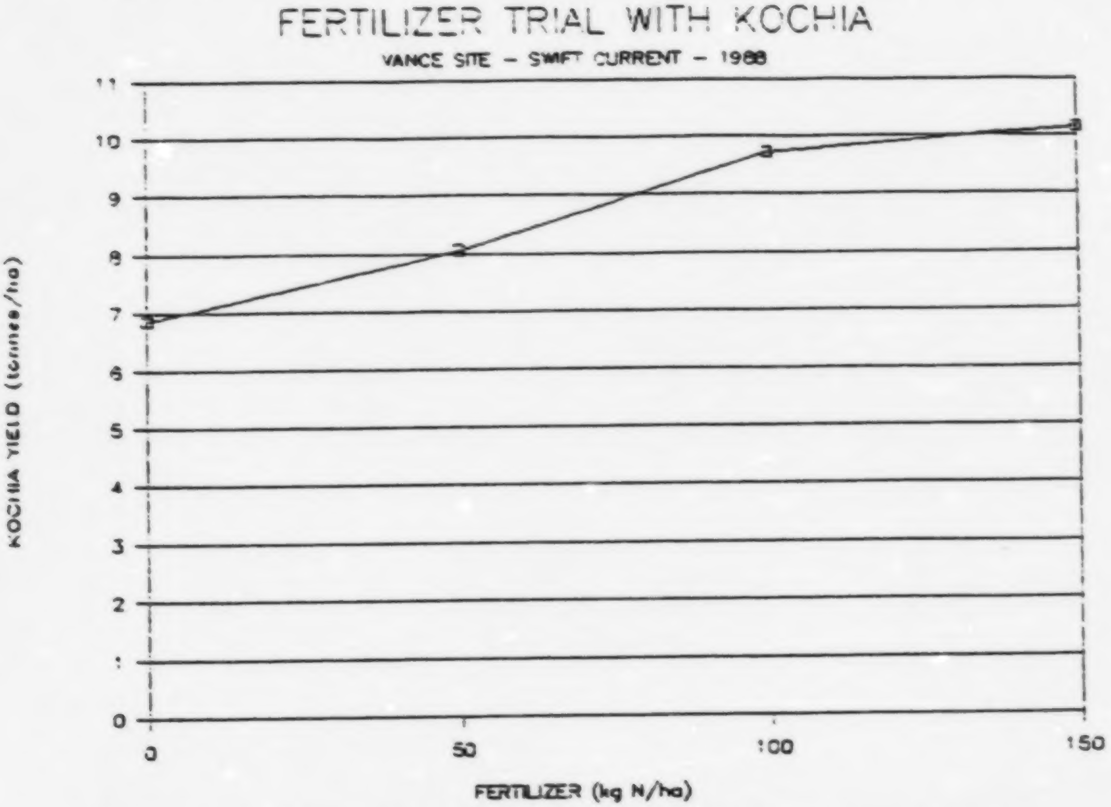
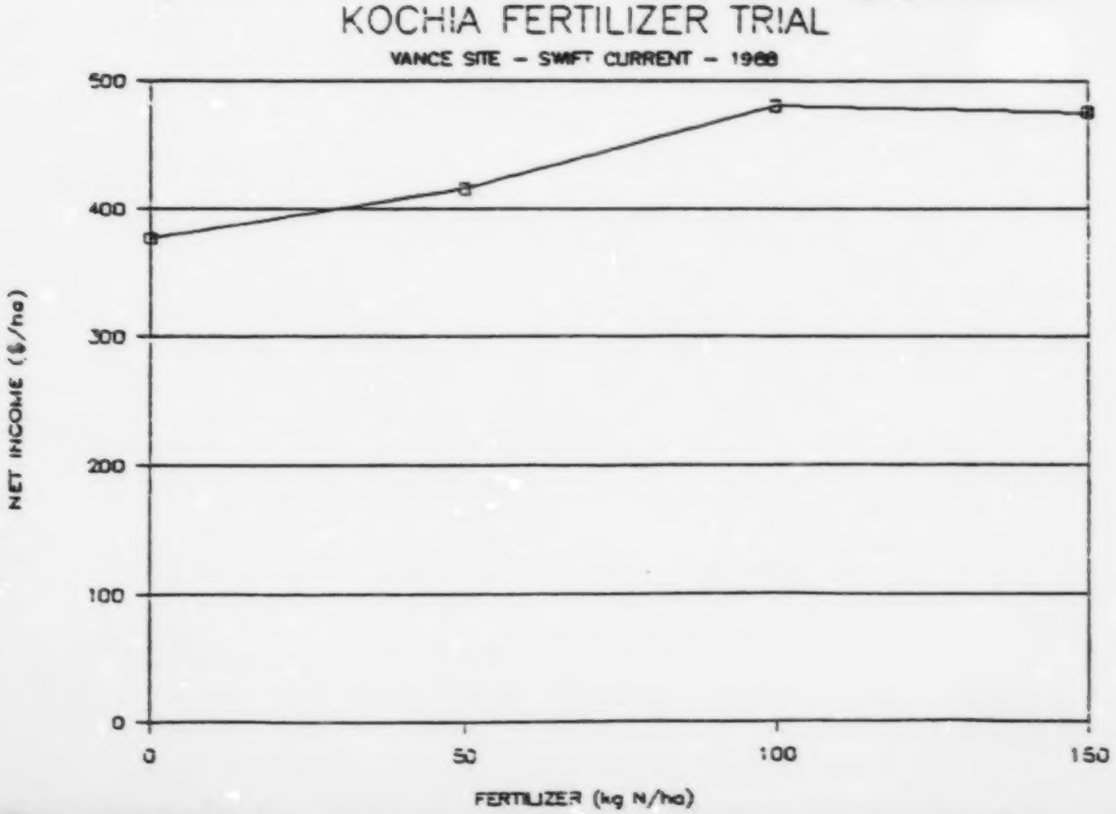


Figure 2. Net income to fertilizer costs of kochia forage production.



2. Brownlee Farm, Briercrest, Saskatchewan, August 16, 1989

About 20 people (50% farmers) attended this field day at the Keith Brownlee. Farmer attendance was lower than expected since early harvest of grain crops had already started. Stands of kochia varied substantially at this site. Some stands were dwarfed, yellow, and crowded. These were growing where kochia had been grown for a number of years in a row without fertilizer being added. Both lack of fertility and the build-up of growth-inhibiting chemicals in the soil (allelopathy) could have been factors in the poor growth of some of the stands.

Where kochia had not been grown so many years in a row kochia yields were much better.

It would be desirable to conduct studies at this site in 1990 on fertilizer effects, crop rotations, and the build up of growth inhibitors in the soil.

Extension activities (J. Hanson)

Preparatory work has been undertaken for the on farm survey to document the feeding pattern of kochia in the wintering ratios of beef cattle across southern Saskatchewan. Names of livestock producers have been assembled into specific geographic areas to facilitate travel and contact. As soon as the harvest of cereal crops is complete and farmers are available for interview, surveying will be undertaken.

Preparatory work has also gone forward to arrange for a display booth at Agribition to further the transfer of information developed from the research undertaken on kochia.

During the growing season of 1989 an on farm demonstration with Keith Brownlee at Moose Jaw was carried out.

Barley was seeded at early and late dates along with grass and legume on to soils that has been a problem due to high salinity levels and regularly invaded with volunteer stand of kochia. A field day was held to demonstrate to other farmers some of the problems but also same potentials in dealing with similar situations of soil salinity and the harvesting and growing of kochia for a livestock feed.

Results of the display booth at Agribition

An estimated 600 - 700 farmers were involved in active discussion with staffers regarding their experiences with kochia over the 7 days that Agribition was open to the public.

The booth was located in Banner Hall adjacent to the livestock barns and therefore was convenient for staffing members to have discussion with livestock exhibitors, many of whom had also had experience in feeding kochia to their herd as a winter feed supplement.

Time was also available on Wednesday, Thursday and Friday to contact several contributors in the commercial barn and to discuss their experiences in feeding kochia to their livestock herds.

In addition there was the opportunity to listen to actual experiences by producers who have been feeding kochia harvested from their saline acreages.

The timing was ideal as vast numbers of producers, mainly across southern Saskatchewan, had harvested and fed kochia through the winter of 88-89, when other normal forage was non-existent. In addition to Saskatchewan farmers we spoke to farmers from south-west Manitoba, southern Alberta, Montana and North Dakota who have also been involved in harvesting and feeding kochia from their saline

APPENDIX TO CHAPTER 11

Extension Articles

Articles in the farm press are one of the more effective methods to reach farmers. We have added as an appendix to this report copies of articles on kochia which have appeared in the farm press or local papers in 1988 and 1989. We have tried to give recognition to the Canada-Saskatchewan ERDA agreement or to the Agriculture Development Fund in interviews with reporters. However, we have no control over whether the reporter chooses to include this information in the final article.

As well as the articles included herein, we have lists of articles which appeared in various local small town newspapers.

SRC News July/88
Request No. 404

A New Forage Crop Emerges

When drought conditions prevail, weeds are often the only plants that continue to grow. That hardiness is certainly the case with kochia, a common annual weed found throughout southern Saskatchewan. Its tolerance of drought conditions and saline soil is already bringing benefits to some livestock producers whose traditional forages are in short supply.

"Kochia is a promising alternate forage and more producers are feeding it to cattle with good results," says Ewen Coxworth, a Principal Research Scientist at the Saskatchewan Research Council (SRC). "Some are even cultivating it as a forage crop.

"We recently completed a three-year study that included a survey of 54 farmers now using kochia. Their experiences with the plant highlighted several attractive features. The two key features are kochia's high water efficiency - it does well, once established, in drought conditions - and its high tolerance of soil salinity." Coxworth says areas of cultivated fields with high salinity levels may be the only places with soil moisture during a drought. "Kochia seems to thrive in these conditions on saline and disturbed soils."

Assisted by Saskatchewan's Agriculture Development Fund, through the Economic and Regional Development Agreement, the kochia project was a joint effort of SRC, the U of S Department of Animal and Poultry Science, and Agriculture Canada's Swift Current Research Station.

Dave Green, of the Research Station, says kochia seeds germinate quickly when moisture is available and grow rapidly during the hottest months of summer. "We have sown kochia here as late as July and still produced useful amounts of forage before freeze-up."

He adds that kochia is not an expensive proposition for farmers thinking of trying it as a forage crop. "Seed is available through several farm supply sources, including the Western Canada Kochia Association at about $2 per pound. Seeding at a rate of three to four pounds per acre, followed by packing, will yield up to two or three tons per acre of good quality forage, even on saline land."

Drought-stressed crops are easy targets for infestation by grasshoppers. But this study showed kochia can withstand severe attacks. "Grasshoppers simply do not like eating the plant," Coxworth says, "and the potential may be there in the future to use kochia extracts as a new method of controlling the insects. Agriculture Canada researchers at Saskatoon are studying the chemical basis of kochia. They are looking at its grasshopper feeding deterrence and toxicity as a guide to building such protection into more conventional crops."

Kochia needs management

Kochia grows wild but Green says it needs management to become a dependable forage crop and to reduce its weedy characteristics. "Left to seed itself on the same site, year after year, kochia develops stunted growth patterns. But a combination of soil cultivation and fertilizer results in healthy stands and high yields.

"First time users can expect greatly improved plant vigor and yield by cultivating the soil and using moderate amounts of fertilizer. And harvesting should start at late bud to early flowering stage before the plant sets seed in late August. This greatly improves the feed value and helps to prevent unwanted wild stands of kochia appearing the following year since kochia spreads as a weed entirely by seed production."

Coxworth says their research included testing kochia seeds from Texas. "This variety does not set seed at all when grown in Saskatchewan. Producers can consider using it in areas where kochia is not already common as a weed."

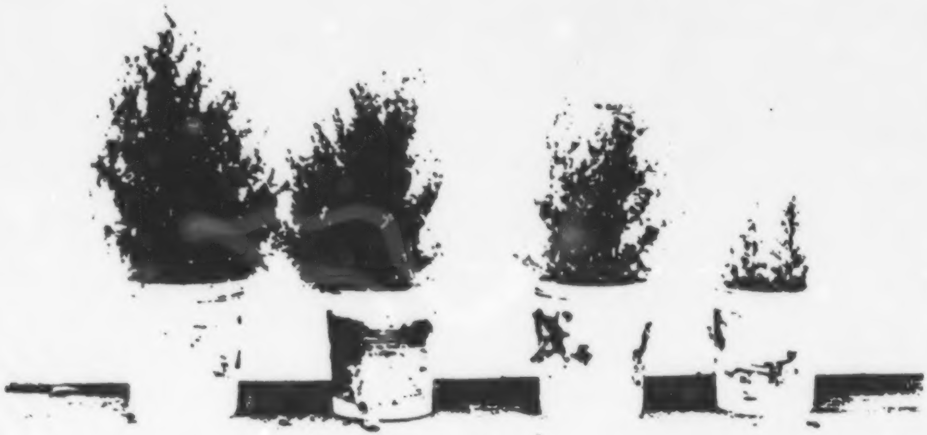
Kochia as a cattle forage component

Improved techniques for growing kochia were only part of the project. Exploring its feed value as a forage involved animal scientists at the U of S. "They found that cattle readily eat it at up to 40 - 50 per cent of their diets, but reject it at higher levels. And the cattle made better use of protein in the feed when kochia was 40 per cent or less of the ration," says Coxworth.

The farm survey showed that most farmers fed only 20 - 40 per cent of the ration as kochia to pregnant cows and reported no problems at that level. Coxworth says farmers should have their kochia analyzed at a feed testing laboratory before starting a feeding program. "Kochia should be tested for nitrate and oxalate, plant products that can cause problems at higher levels."

Coxworth and Green see potential for developing kochia beyond its present level as most farmers using it now are simply taking advantage of wild stands. They say the next step for kochia research will focus on plant selection and breeding to help change it into a non-weedy crop that can be cultivated and harvested for forage.

Effect of Nitrogen Fertilizer on the Growth of Kochia



N Fertilizer (ppm)	145	97	48	0
Yield (grams/pot)	100	95	84	27
Crude Protein %	17.6	13.5	8.9	8.5
Nitrate %	trace	0	0	0
Soluable Oxalate %	3.5	2.4	1.8	0.7

Spring soil cultivation helped produce a healthy stand of kochia (right). No soil cultivation (left) resulted in a stunted, crowded stand.

THE FURROW

SUMMER 1989 • VOL. 94, ISSUE 5

This issue's cover: Melons are just one of many produce crops that are being grown on a larger scale outside of traditional production areas. As explained in the cover story, starting on page [illegible] this trend means new competition for some farmers and new opportunities for others. Photo by Tom Sizemore.

ARTICLES AND REGULAR FEATURES

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> *". . . FOR WHAT AVAIL THE PLOW OR SAIL, OR LAND OR LIFE, IF FREEDOM FAIL?"*
> *—RALPH WALDO EMERSON*

Why we write about snail farming and elk ranching

The majority of articles that appear in *The Furrow* deal with major crop and livestock enterprises—corn, soybeans, wheat, cotton, beef cattle, dairying, and so on. In an attempt to be as helpful as possible to our readers, we concentrate on writing about the things that most of them produce.

However, many *Furrow* issues published in the past few years also have included articles about agricultural enterprises that aren't in the mainstream. For instance, we've written stories about people who raise and market such specialties as alligators, squab, ginseng, flowers, aloe vera, quail, and snails. Other examples include articles about a man who specializes in raising and selling queen bees, the production of exotic mushrooms, and farmers who grow horseradish. Even this issue's cover story, which deals with the spread of fruit and vegetable production, concerns crops that relatively few of our readers grow.

One reason we publish such articles is to illustrate some of the possibilities for diversifying farming operations, a business strategy that regained a degree of popularity during the recent agricultural downturn. We want to show you how some farmers have increased their incomes through specialty enterprises.

But this is not our major purpose in writing about such subjects as snail farming and elk ranching. We know that large numbers of our readers won't be able to make up for low returns from corn or cattle by growing mushrooms or ginseng. The markets for specialty products are just too small to absorb big increases in supplies. Rather, our primary goal in featuring offbeat enterprises is to help our readers understand and appreciate the wonderful diversity of modern agriculture. We think the best way to do this is to explore farming's fringes, its nooks and crannies. We hope you're as fascinated as we are by what we find./
George Sollenberger

KOCHIA: HERE TO STAY

This sometime weed is finding a niche as a forage crop for saline soils

The drought of 1988 was different than other dry seasons in at least one respect, a Saskatchewan farmer noted recently. What made it different, he said, was that a lot of cattlemen didn't run out of feed.

The reason: the thousands of tons of kochia that were put up last summer as hay or silage.

The effective use farmers and ranchers made of kochia pretty much erased any remaining doubt about kochia's right to be ranked as a bona fide crop for the Canadian Prairies, especially on saline soils. Now the focus is on improving kochia yields and its feeding value.

As for boosting yields, one strategy is to improve volunteer stands through tillage. Because kochia propagates by seed only, disturbing the soil stimulates germination and added growth. Many farmers work up a field and seed it to barley, allowing the kochia to dominate on the saline patches.

If you want to fertilize continuously cropped kochia, the general recommendation from Agriculture Canada is 50 pounds of N and 20 pounds of P_2O_5 per acre. Too much nitrogen, however, can lead to toxic levels of nitrate in the plant.

Kochia seed. More and more farmers are seeding kochia to augment volunteer stands. An increasing supply of kochia seed is being grown by a handful of kochia-seed producers in western Canada. The small seed needs to be shallow planted into a firm seedbed at the rate of 3 to 4 pounds per acre, followed by packing. The seedbed should be free of mustard-family weeds such as flixweed and stinkweed.

Will the seed from this kochia persist in the soil to haunt future crops? "Kochia should be cut for hay or silage in the bud stage well before it sets seed, and this will help control carryover," says Darald Marin, a farmer near Radville, Sask., and a pioneer grower of kochia seed. As another precaution, Marin recommends standard summerfallow tillage after harvest to kill plants that escape the cutter bar. Failing that, kochia can be controlled with a number of herbicides.

Kochia pioneer Darald Marin says kochia can rehabilitate salt-affected soils while producing a valuable forage.

Kochia seed from Texas strains has sometimes been recommended for planting because these plants don't set seed under Canadian conditions. However, Texas kochia has been found to have substantially higher nitrate levels than native Canadian strains, adding to the risk of livestock poisoning.

In the future, farmers may be planting improved kochia strains with growth habits that make them less likely to persist as weeds. A great deal of genetic diversity exists in native Canadian kochia, says Dave Green, a plant physiologist at the Agriculture Canada research station at Swift Current, Sask. Scientists are trying to identify superior plants and propagate them. Another goal of this research is to develop strains that are more nutritious, more palatable, and safer to feed to livestock.

But at present, no one foresees these improved kochias as becoming a major forage crop on good soils. Kochia's niche seems to be in utilizing moisture and nutrients on salt-affected land where little else will grow.

Green and others believe kochia will play an important role in halting, or even reversing, the buildup of salt that is laying waste to more and more land every year. Kochia roots penetrate hardpan, drawing water from deep within the soil profile, says Darald Marin, the kochia-seed producer. This dries up wet spots and also provides channels for rain and snowmelt to leach surface salts below the root zone of cereal crops. While it's doing this, kochia can produce up to 3 tons per acre of a nutritious forage ranging from 8 to 20 percent protein. Marin has seen kochia work a dramatic change on some of his soils. He refers to one 40-acre salt-affected field that had grown little since he bought the land in 1975. After two crops of kochia, he was able to grow a crop of barley.

Renovator. Kochia also thrives on soils that are too saline for alfalfa or tame grasses to become well-established. "By growing kochia on some of these sites, I think we can eventually get alfalfa and tame grass started on them," Marin adds.

Kochia does require some care in feeding, mainly because of the high nitrate accumulations that can occur under some conditions. In North Dakota last year, kochia was one suspect in the deaths of cattle from six different herds. North Dakota livestock specialists were cautioning farmers to keep kochia down to 50 percent or less of the rations.

Kochia may also contain excessive levels of oxalate, an organic acid. This compound can tie up calcium, leading to a mineral deficiency. Feeding dicalcium phosphate can prevent this problem.

Marin agrees that 50 percent should be the upper limit for kochia in the ration. When fed at higher levels, he says, feed intake goes down. According to Marin, some cattle producers are feeding kochia at the 30-percent level with native hay, using kochia to boost the ration's protein content.

So kochia isn't exactly a candidate for a "Feed of the Year" award. But then no weed is perfect./**John Dietz and Rollie Henkes**

A CASE IH PUBLICATION

CANADIAN FARMING

FALL 1989

RED MEAT FIGHTS BACK
How Canadian cattle and pork producers
are changing consumer tastes again.
ALSO:
Sunflowers bloom in Manitoba
A weed for feed
The future for orchards

▲
DAVID GREEN (with Texas Kochia in right hand, Saskatchewan variety in left): "Pretend you're planting barley and you'll get Kochia!"

A WEED FOR FEED

A prairie pest may be the answer to growing forage in saline soil

For years, Saskatchewan farmers have had to deal with two pesky problems on their land.

One is the spreading concern of soil salinity. And the other has been a spreading weed. Now it appears that the problem weed might prove to be the answer to the problem soil.

The weed is Kochia, whose bushy emerald green plants are found from Manitoba to Alberta and as far north as Prince Albert, Saskatchewan. First introduced from its native Turkey as an ornamental species, Kochia soon became a fast-growing pest thriving along roadsides and among grain fields. In fact, grain farmers still think of Kochia as a good-for-nothing weed that's difficult to kill once it is established.

But livestock farmers are looking at it differently. For not only does Kochia possess nutrient qualities similar to alfalfa; it is the only crop which can tolerate certain types of saline soils.

"High salinity in our soil is becoming a major problem," says David Green of Agriculture Canada's Swift Current Research Station. "And it's a direct result of our summer fallow practice we use to conserve moisture here on the Prairies."

Green explains that the moisture conservation practice can work too well and actually be counterproductive.

"If we conserve too much moisture some years, it can lead to a movement of the water deeper into the soil than normal, all the way down to the saline level which plants normally wouldn't come in contact with. Later the water migrates back up to the surface, bringing this excess salt with it."

Very few plants other than Kochia will grow in saline soil and, until now, none have been crop plants.

But an analysis of Kochia reveals it has a nutrient profile similar to alfalfa:

	ALFALFA	KOCHIA
Protein	22%	18%
Energy	58%	56%
Calcium	1.6%	1.2%
Phosphorous	0.25%	0.25%

There's more good news: grasshoppers hate Kochia! When they are forced to eat it, something happens to their reproductive abilities, virtually wiping out the emergence of new hoppers from the next generation.

Farmers afraid of spreading Kochia to the fields of neighbours – who won't appreciate its propagation, especially if they are grain growers – can use a Texas strain. Texas Kochia produces larger stands and has the benefit of being non-propagating since the plant is killed by frost before it has a chance to set seed.

Is this the perfect plant for its time, one that's drought-resistant, grows in saline soils, actually helps kill off grasshoppers and can replace alfalfa as a quality cattle forage crop?

Well, not quite perfect.

"There's no question about all its good characteristics," agrees David Green, "especially its high biomass and the fact that you can easily get yields of two tons per acre of Kochia rated at 13% minimum protein. But there are a few problems livestock growers have to keep in mind."

Barry Peterson, a Livestock Agrologist with the Saskatchewan Rural Development service, agrees.

"We caution ranchers against using Kochia as cattle feed for more than half of their total dry matter," he warns. "If you stay between 20% and 40%, there should be no problems replacing alfalfa with Kochia."

The principle drawback with Kochia appears to be the quality of its calcium content. While the level is impressively high, not all of the calcium can be used by the animal. "We have histories of cattle actually going blind due to calcium deficiencies when they've been fed too much Kochia," he says.

There have also been some cases of jaundice recorded in Kochia-fed animals, but this has been controlled by adding grain to the ration.

"We're also concerned about high nitrate levels in Kochia grown in some regions," Peterson adds. In summary, he advises ranchers who may be considering Kochia as a forage crop to keep within the 50% content for total dry feed matter and to have crop samples tested for possible high nitrogen levels and possible other toxic constituents.

Kochia seed, while not registered, is available from several farm supply sources. But many Saskatchewan farmers, depending on the concentration of Kochia plants in their area, may not have to purchase seed at all.

"One way to grow Kochia around here is to pretend you're growing barley, but don't plant barley," David Green suggests. "And you'll get Kochia!"

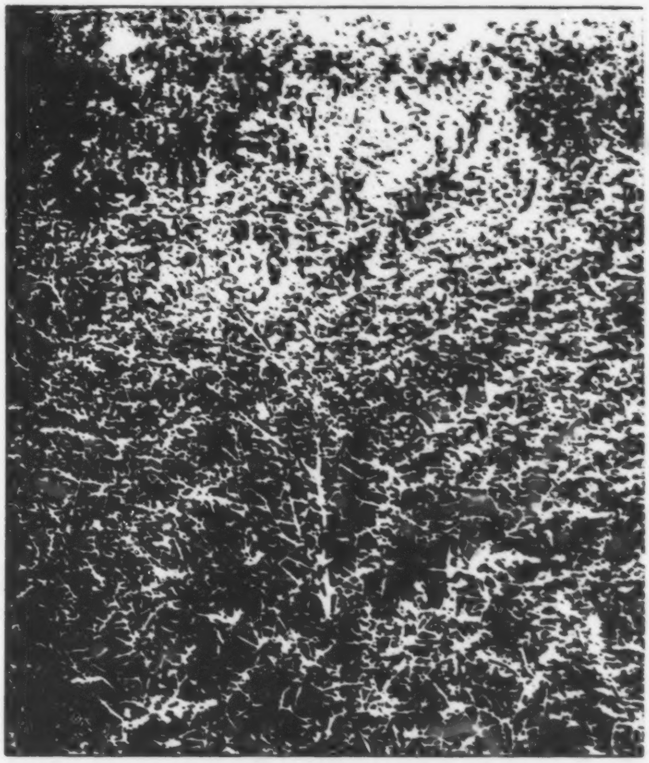
◄

BARRY PETERSON: "We have records of cattle going blind on nothing but Kochia."

In this Saskatchewan field, Kochia has thrived in areas too saline for the planted barley to survive in.

▼

Kochia the weed becomes kochia the feed



After last year's drought, kochia, once viewed as a troublesome weed, is now regarded by some ranchers as a useful silage crop for saline soils

That leafy, sometimes stemmy, salt-tolerant plant, kochia, has found a home. For some producers, kochia is now a useful feed instead of a useless weed.

"We got involved with kochia because it was a cheap source of feed and we found it grew well on the alkali land we have," says Bevin Smith, who runs a 275-head commercial cow/calf operation near Abbey, Sask. During last year's drought, he worked some land and grew kochia for silage. "We put up close to 1,000 tons of kochia silage, with a bit of thistle in it, and we fed over 500 round bales of kochia," he says. And he's got another kochia crop growing now, on land seeded last year to oats, which succumbed to the drought.

"What kochia likes is cultivation," he explains. "I had planned on seeding kochia on that land, but it came in well by itself so I let it go. That's the beauty of kochia; it will grow voluntarily in those salty areas where other crops have a tough time."

Dave Green, a forage specialist at the Agriculture Canada research station in Swift Current, Sask., who also runs 75 commercial cows, has been feeding kochia in his operation for over 9 years. He has a keen research interest in the plant and agrees with Smith: "We're not competing with alfalfa or wheat; that's a key point. Most of the land where kochia grows is saline, so not much else will grow there anyway," Green notes. He says over 90% of the kochia that grows in Saskatchewan is volunteer; very little is seeded.

Kochia is a very "proficient" seed setter, Green explains, and the low branches that escape swathing readily produce the 3 to 4 pounds of seed per acre that's needed to re-establish the crop the next season. He notes that kochia has no trouble producing 600 pounds of seed per acre.

It is important, he adds, to work the land and prepare a good seedbed each year. "If you don't prepare the seedbed, kochia will only grow about an inch tall and then weeds like foxtail barley will come in. After 3 or 4 years, you won't have any kochia left," Green points out.

Smith says harvesting kochia is no tougher than other forages, but timing is a key. "Just like anything else, a lot depends on when you cut it," he says. "With kochia, the budding time isn't as critical as it is with alfalfa, at least not for feed quality. If you let it go too long, though, you'll get a lot of stems."

He waits until the plant is more mature, sometime after flowering, but admits it is tough to judge flowering because plants are at different stages of development across a field. But it runs through the forage harvester as well as anything, he adds. This year, if conditions continue to be right, he expects to get close to 4 tons of wet silage per acre, or about 2 tons of dry matter.

On average, says Green, yields of 2 tons per acre at 15% moisture are common. You do have to crimp it though, and it takes about twice as long as alfalfa to cure in the swath. "Round bales or square bales, it goes up well both ways if you're putting up hay. One of kochia's attributes is it really holds onto water in the hot dry weather when it's standing; cut it and it does the same thing in the swath.

"What we try to do is maximize the yield and cut it in an active growing stage when it hasn't fibered up," Green says. As a rule-of-thumb, he suggests cutting kochia before it starts to wilt (after flowering); by then, quality starts to drop off rapidly. "You could also cut it twice," he adds. "If there's enough moisture in the soil and you cut it high enough the first time, it will come back."

Smith says kochia's feed quality compares favorably with alfalfa. His feed tests show crude protein levels range from 12.5% to 14%. Put up correctly, he says, the silage is leafy and very palatable when fed at 50% or less in the ration.

Green says the nutritional value of kochia is good, with crude protein levels sometimes as high as 18%. If the crop is cut near first bloom, total digestible nutrient (TDN) levels range from 58% to 60%.

He does have some words of caution, however. "If kochia is grown on a saline site, as most of it is, it will contain a lot of salt and that will reduce the tendency of the cattle to take salt in voluntarily. That may lead to low iodine intakes in the cows," he notes. "So we recommend mixing salt and trace minerals in the ration." He also suggests that kochia not exceed 50% of the dry-matter intake. "Beyond that, you can get depressed calcium levels in the blood because kochia has oxylates that tie up calcium.

"We recommend kochia strictly for wintering beef cows and we don't recommend it as a pasture, because when cattle get on staight kochia, that can be a problem," he adds. (Cattle grazing kochia would take in more than the recommended 50% dry matter, leading to possible metabolic problems.)

Smith tries to ensure that mineral and vitamin levels are right when feeding kochia. "It's wise to keep Vitamin A levels high, maybe 40,000 to 50,000 I.U., about double the normal required levels.

Last year, Bevin Smith managed to get 1,000 tons of kochia silage off some rather poor saline land

"You'll also want to keep the calcium levels up," he notes. "We tubground the feed with mineral mix and have top-dressed as well. It's a good precautionary measure and it doesn't cost that much to do."

Presently, Green says, most of the kochia seed used in western Canada is being collected from native plants, and research is underway at the Saskatchewan Research Council in Saskatoon to develop new varieties. He adds, however, that they are "a long way off".

And Smith's plans for kochia? "It doesn't always grow well, but it works in our cow herd management and we'll sure use it at every opportunity."

— Larry Thomas

Revising an alfalfa commandment

Minnesota researcher Craig Sheaffer contends that with modern management, alfalfa can be cut as late as October with no ill effects. But Guelph, Ont., researcher Steve Bowley argues that cutting that late isn't worth the risk. Alfalfa needs to rest 4 to 6 weeks prior to a killing frost to accumulate winter root reserves and enhance its cold tolerance.

The 2 researchers debated the pros and cons of late-cutting alfalfa at the recent American Forage and Grassland Council annual meeting in Guelph. It's the first time the group has met outside the U.S.

First, Craig Sheaffer: He claims current extension advice about not tampering with the fall rest period is flawed because it doesn't give enough weight to the time between cuttings. Sheaffer adds, "It's not the calendar date of the final cut, but the interval between cuts that's important."

Mid-80s research at Minnesota and Michigan found no difference in persistence and 3-year yields in well-fertilized Vernal alfalfa when a third cut was taken on August 30, September 15, or September 30. These cuttings were followed by winters with adequate snowcover and were from soils with high phosphorus and potassium levels, however.

Sheaffer agrees that fall cutting may sometimes pose a risk to long-term persistence of alfalfa stands. But some factors that affect this persistence, such as varieties, soil fertility, cutting schedule, stand age, and cutting height, can be controlled to lessen the risk.

Take varieties, for instance. Today's modern cultivars have built-in resistance to bacterial wilt and other major diseases. If potash is used at adequate rates, there's no problem with cold tolerance. And if a 50-day regrowth period is allowed between cuts, there seems to be no ill effects. In terms of stand persistence, Sheaffer claims delaying the third cut until the fall due to poor weather is much less detrimental than taking a fourth cut in the fall.

As to stand age, current research suggests younger stands can better withstand fall cuttings than 4-year old mature stands. Leaving a 6" stubble on the final cut to catch snow for insulative cover also helps avoid winter injury.

The remaining risks depend on the weather because you can't control snow cover, temperature fluctuations, or soil moisture.

Steve Bowley, on the other hand, maintains that the low yields gained from fall cuttings aren't worth the risks involved. Aside from the low yield, he notes, it's difficult to get a late-mowed crop dried and stored. And winter annual weeds may get a toe-hold in a field stripped of its dense alfalfa cover.

In addition, he says, this late growth provides needed ground cover for trapping snow and insulating the plants over winter. All of this contributes to the stand's longer-term persistence.

At Chatham, Ont., Bowley reports intensively managed alfalfa only produced 5% to 9% of its total seasonal yield from September to November. Although the quality is high, the yields are pitifully low.

"From my perspective," says Bowley, "the disadvantages far outweigh the advantages of a fall cutting of alfalfa. It would be best not to harvest alfalfa during or after the critical fall harvest period if one wants to ensure persistence, long-term productivity, and quality of an alfalfa stand."

Both men agree that fall cutting is a risk management exercise. Before you do it, they suggest you assess the following factors:

- Stand age: The older the stand, the greater the risk of fall injury.
- Variety selection: To reduce injury, choose varieties with higher resistance to bacterial wilt, verticillium wilt, and phytophthora root rot.
- Fertility: High potash levels in the soil, above 120 parts per million, will reduce risk of winter injury.
- Drainage: Well-drained soils lessen the potential for winter damage.
- Harvest frequency: Two cuts per year is safe, but taking 4 cuts is much riskier than removing 3 cuts.
- Cutting practice: Leave 6" of stubble on the final cutting to catch snow and reduce the chance of winter damage to the plants.

— Karen Davidson

26, 1989

news

ATTLEMAN'S CORNER

'First to bring you new farm ideas'

nouncements, expected to be released in early April.

- Shortage of seed supplies, particularly wheat and barley, in some areas.
- Moisture conditions at seeding.

FarmDecision Resources is a research and consulting firm owned by United Grain Growers.

—J.C.

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And then we can sell our malting barley, by compulsion, 90 cents, a dollar, $1.15. When we discover that the brewers pay far more, we can sue, in the Courts, and we are told that we are *not entitled* to any accounting.

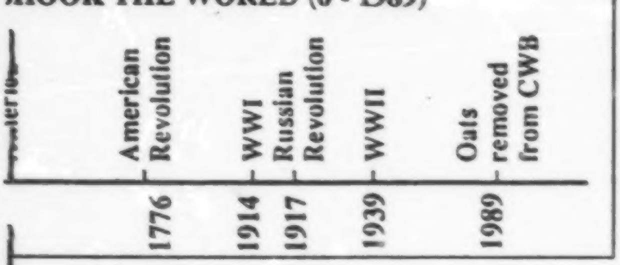
We sold, under compulsion, to an Agent of the Crown.

We can weather a have regard clause, three, four, five, six, maybe seven **good** crops. Wheat, the lifeblood, the inspiration, the raison d'etre, the soul of Western Canada, sacrificed, stolen, yes and transshipped for re-sale into international trade at twice, three times the price we were given under "orderly marketing." And all because of a colossal political blunder, an irresponsible manipulation of the despised West by our Ottawa masters.

And they had a vehicle, an

(please turn to page 4)

HOOK THE WORLD (0 - 1989)

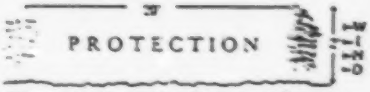


Plan barrier strips for this year's summerfallow

Kim Hartman turned concern and frustration into a handy seeding tool that will help other farmers fight erosion.

Hartman's K-Hart Barrier seeder is a self-contained seeder, run by an electric motor, that mounts on any cultivator and most rod weeders. The 2-bushel tank, fluted feed cup and electric drive feed a 5- to 6-inch scatter boot that mounts behind a shank or opener.

The K-Hart Barrier seeder (yellow frame) mounts on cultivators and rod weeders.



The wind protection can be up to 10 times the height of the barrier.

"The K-Hart Barrier seeder plants a barrier strip to trap snow and cut wind erosion," says Hartman. "The idea isn't new but when I looked around and couldn't find any equipment at the dealers, I decided to make my own.

"It was bad enough to see the snow blow away without being able to catch it, and now lately, we have to watch the soil drifting away," says Hartman. "The Barrier seeder is used to plant a barrier strip of flax, mustard, canola or Texas kochia, as part of a mid-July summerfalow pass. This strip, under normal conditions, will provide adequate protection for 10 times the barrier height."

Hartman points out how this operation actually pays for itself and may show a profit,

(please turn to page 4)

er – 6 × 6 = yield

lerstand what an inch of water is worth

VASEY

, as the fuel that runs t plants' engine, is the ting need of the spring lant in the Northern lains.

orth of water to spring between 0 and 9 per inch. Bushels per water is called water use tices. Better WUE for wheat can be obtained with good fertilization management, especially management of nitrogen. Use of a nitrate-N soil test to two or four feet is a must to get the best WUE from the wheat plant's engine.

Most spring wheat growers will long remember 1988 as an example of a year when an inch will also relate to 1985 as the year they, perhaps, had a WUE of 8 to 9 bushels per inch. Good growing season rainfall combined with cooler temperature were dominant factors allowing such WUE to be obtained.

As farmers see and hear WUE values cited, they should know what method of calculation was used. Here's a and the final yield was 35 bushels per acre. WUE is 35 bushels divided by 14 inches, or 2.5 bushels per inch of total water used.

If values cited are 3.5 to 9, the researcher has likely calculated WUE based on water used from heading to harvest.

Various spring wheat data indicate it requires 5 to 6 inches of to make a wheat plant

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● *Full 4-row frame provides unmatched trash clearance.*
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igged shank design al- and low maintenance.
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common denominator, which is the foundation, the basic premise of total, inescapable, uncontested government control.

Over a period of 48 years, orderly marketing has assured us the lowest possible price, and given us just that, in almost every case. Canadian wheat is renowned the world over for its quality, its uniformity, its color and its vanishing value. Final payments evaporate like the

(please turn to page 7)

Plan strips

(continued from page 1)

over and above the reduction in soil erosion. "Yield increases of only a few bushels per acre can greatly increase profitability.

"This is an investment operation. It helps the land and helps your next crop. Last year's drought shows how you have to plan ahead. We had enough trouble getting crops to grow, let alone barrier strips planted in July. We now know you do this wind control all the time, as insurance for bad times as well as on-going payback."

The barrier seeder idea also fits into another of Hartman's plans. He had been looking for an idea that could be manufactured on the farm but, until now, couldn't find a product that was needed. "I've already started production amd getting some dealers interested."

Hartman can be contacted at the farm: K-Hart, Box 413, Elrose, Sask. S0L 0Z0. Phone 306-378-2926. —K.B.

"Then what d'ya do after you put soap on the dishes?"

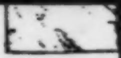

Figure 5. broken in

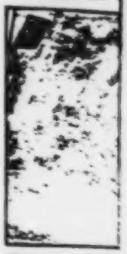

Figure 6. pulley.

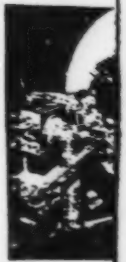

Figure 7 welding t

Repair pulley

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Dave Barbour, CIDA

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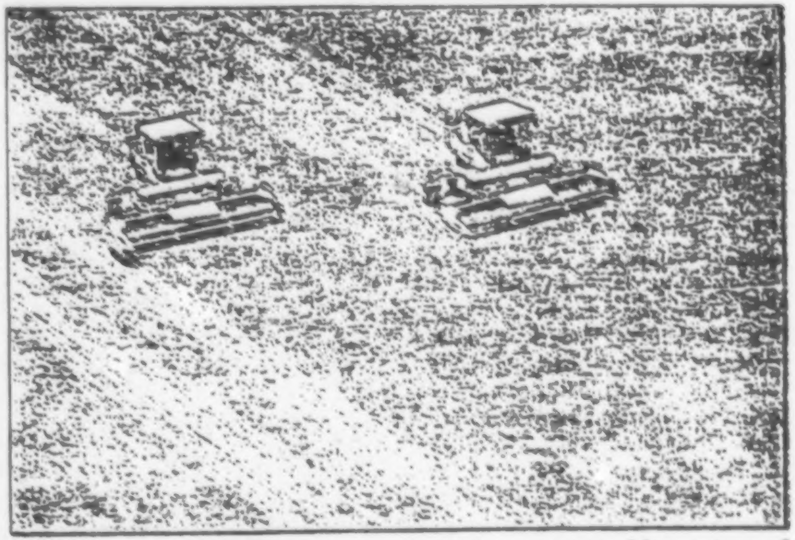
Grainews March 20, 1989 Pg 125

Irrigated alfalfa yields 4 tonnes an acre


Land that was fit for pastures only now yields an average of four tonnes of hay a year.

Over the last several years, irrigated alfalfa on the Rudy-Rosedale community pasture has yielded nearly four tonnes an acre.

The 520 acres of alfalfa is part of the community pasture north of Broderick, Sask. The irrigation project is managed by the Saskatchewan Irrigation Development Center in Outlook. They spent many hours filling blow holes and low spots in the field before setting up the pivot system.

"We still have wet spots where the alfalfa floods out," says SIDC [illegible]

The 520 acres are under a low-pressure pivot system, explains Tollefson. The pivot is operated for 1500 to 2000 hours each year and pumps 18 to 20 inches of water in 25 passes.

As the water for the project is recycled from a drainage ditch, "we've had real problems with weeds and trash plugging the intake and shutting us down," says Tollefson.

To overcome this plugging problem, a hydroscreen which screens out weeds and debris was installed [illegible]

Derdall grows 19% protein kochia for hay

Not only does kochia do extremely well on saline soil, it equals alfalfa in protein.

According to forage researcher Deneen Duncan, kochia grown on severely saline soils has outyielded tall wheatgrass and slender wheatgrass. "The yield advantage being the greatest where the salinity was the highest."

Yields of four to five tonnes on an acre can be obtained on saline land, says the Saskatchewan Irrigation Development Center (CIDC) researcher.

Ray Derdall, near Broderick, Sask., grew Texas kochia that had an average protein level of 19% and an average TDN of 55%.

However, kochia has a couple of pitfalls. In certain areas, it's a weed and a very prolific, hard-to-kill one at that. It can survive most anything, or so it seems.

The other problem is its tendency to accumulate nitrates and oxalates which are toxic to livestock. Duncan suggests that, if you grow and feed kochia, "always have a feed analysis done to determine potential toxicities and then feed it equal or less than 50 per cent of your feed ration."

The SIDC center at Outlook has been testing kochia both at Broderick and at Val Marie.

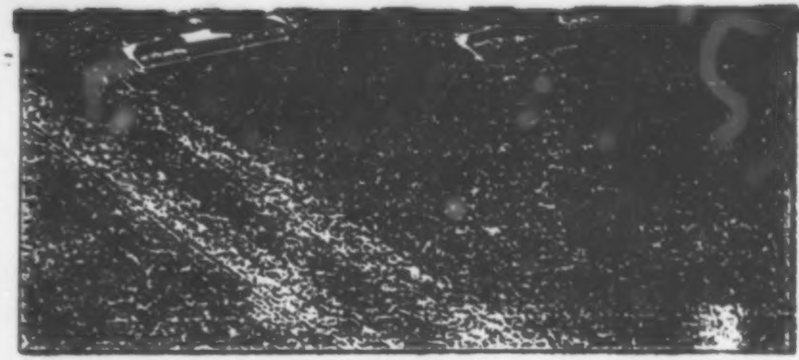
Duncan says there are two strains of kochia being grown: the [illegible]

Dick Middleton, near Vulcan, Alta., grows kochia on his saline areas and uses it for both silage and pasture. It's been his main forage for the last five years. When grazed, he moves cattle into new kochia pastures every few days.

spreading weed seeds," she says.

Here are a few tips from Duncan for harvesting kochia:

- Harvest the kochia at the late bud to early flower stage. Harvest at a later date will show a decline in the feed value of the forage.
- Crimp the hay to hasten drying. Thick stems slow down the drying of the kochia. Preservatives may be used to alleviate this problem. Ray Derdall baled his kochia [illegible]



Land that was fit for pastures only now yields an average of four tonnes of hay a year.

Over the last several years, irrigated alfalfa on the Rudy-Rosedale community pasture has yielded nearly four tonnes an acre.

The 520 acres of alfalfa is part of the community pasture north of Broderick, Sask. The irrigation project is managed by the Saskatchewan Irrigation Development Center in Outlook. They spent many hours filling blow holes and low spots in the field before setting up the pivot system.

"We still have wet spots where the alfalfa floods out," says SIDC manager Laurie Tollefson. "We have been hauling dirt in to make bridges for the pivot to get through these."

The 520 acres are under a low-pressure pivot system, explains Tollefson. The pivot is operated for 1500 to 2000 hours each year and pumps 18 to 20 inches of water in 25 passes.

As the water for the project is recycled from a drainage ditch, "we've had real problems with weeds and trash plugging the intake and shutting us down," says Tollefson.

To overcome this plugging problem, a hydroscreen which screens out weeds and debris was installed in a concrete structure between the canal turnout and the pump well.

(please turn to page 132)

[redacted]tras[redacted]he [redacted]adv[redacted] being the greatest where the salinity was the highest."

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The SIDC center at Outlook has been testing kochia both at Broderick and at Val Marie.

Duncan says there are two strains of kochia being grown: the native strain already present in Saskatchewan and a Texas kochia. The Texas kochia "rarely sets seeds under Prairie conditions, thus eliminating the risk of spreading weed seeds," she says.

Dick Middleton, near Vulcan, Alta., grows kochia on his saline areas and uses it for both silage and pasture. It's been his main forage for the last five years. When grazed, he moves cattle into new kochia pastures every few days.

Here are a few tips from Duncan for harvesting kochia:

- Harvest the kochia at the late bud to early flower stage. Harvest at a later date will show a decline in the feed value of the forage.
- Crimp the hay to hasten drying. Thick stems slow down the drying of the kochia. Preservatives may be used to alleviate this problem. Ray Derdall baled his kochia at about 25% moisture, using a preservative without any spoilage.

Kochia may be the answer to increasing the productivity of severely saline land," says Duncan. ☐

Hay pays well for Alberta farmer

there, either for silage or hay. There's not usually very much hay, but the clipping prevents weeds going to seed.

"One year, I left it too long — until late in July — and my weed control wasn't all that good. Some of the stinkweed shelled out. It's important to get it seeded early in the year so you have the growth for that early cut and weed control."

Greig has considered using hay additives. But rather than applying chemicals or bacteria, he uses a double rake.

He rakes two swaths together early in the morning so as not to shatter the leaves too badly.

In the afternoon, when the hay has dried down below 15% moisture, he bales the two swaths together. "We can bale twice as fast," he says. "I don't know if it's really better but it works for us. Time is at a premium because there's just

Farmer proud of his field of weeds

Kochia likes salty soil, cattle like it and everybody likes another forage crop

By Elaine Shein
Western Producer reporter

OUTLOOK, Sask. — As other people drive past Ray Derdall's field, they may think it's a field of weeds, some growing taller than two metres.

Not bad, considering the Texas kochia began from seeds the size of pepper and are on alkaline land.

"Barley would have grown about a foot and died here," explained Derdall. "But the kochia utilizes the salt."

This is the third year he has grown kochia on his land, seeding 30 acres this season.

Kochia has been known as a stubborn weed that grows from Melfort, Sask., to central Mexico, and it wasn't until last year that it "made its emergence as a crop of any significance," said Dave Green, a forage researcher at Agriculture Canada's Swift Current research station.

While some people have grown it for several years, farmers didn't start accepting it until they were affected by last year's drought. The kochia was more available and cheaper than hay to purchase as a livestock feed.

Green said kochia should be considered for saline soils: "We're not trying to compete with the better forages such as alfalfa or grass."

But Derdall said there are a lot of advantages to his Texas kochia: It's helping with soil reclamation, yields well and grows high, doesn't go to seed, and has a high protein content. Kochia is also grasshopper resistant, according to Green.

But kochia, especially the Texas variety, can have dangerously high levels of nitrates. So Green and other researchers will be testing 100 different lines of kochia next year.

"We hope in three years to have a line much better than the native plants, where we know organically they're good yielding and chemically they're also good [for nitrate level and protein digestibility]," Green said.

He cautioned not to use more than 50 percent kochia in rations. Using more leads to reduced animal gains because of the high nitrate level. Kochia feed should also include hay, straw and a small amount of grain, about two or three pounds a day as an energy factor, he said.

Kochia's protein level is high, about 13 percent or higher, while cattle only need about nine percent protein during winter, Green said. Derdall said some of his Texas kochia last year tested 24 percent protein.

Green said people considering whether to get the native or Texas kochia should consider the area they're in.

"If they're in saline areas, producers should ask themselves, 'Do I already have a fair amount of kochia in this area? Are the saline patches already contaminated with kochia?' If so, use the native kochia."

The native kochia seed costs about $2 a pound and once it's grown on saline land it reseeds itself.

"But if they don't have a problem, go with Texas kochia, not introduce kochia into an area that doesn't have it," Green said.

Because the Texas kochia doesn't go to seed, it can grow longer and is easier to contain in the area wanted. The Texas kochia costs about $5 more per pound.

Green said if three to four pounds of native kochia seed are planted per acre, it will produce 600 pounds of kochia an acre.

Texas kochia should be seeded about two or three pounds to the acre, and not more than about 13 millimetres deep, Derdall said.

Green recommended people allow native kochia to grow until the leaves stop growing and the kochia begins flowering, at about one metre high.

Texas kochia can be allowed to grow longer because its leaf stage lasts longer. As long as it hasn't run out of moisture and the leaves are green and not wilting, the kochia could grow up to two metres high.

WP photo by Elaine Shein

Ray Derdall and his kochia crop: "Barley would have grown about a foot and died here."

lanting forage crops needs careful planning

k. Agriculture news

Careful planning and proper seeding are ential for a good forage crop.

Forage crops can lead to increased produc- ty and financial gain for farmers, but seed- g failures are common," says Don Gayton, of [illegible]

situations.

"Spring seeding is probably the most common and possibly the most effective time to seed forage crops," Gayton said. "However, late fall seeding of these crops, carried out once soil temperatures are cool enough to prevent seed germination, can also be both effective [illegible]

allows the seed to lie dormant and to germinate first thing in the spring.

Seeding into clean stubble, which has been treated for fall annual weeds, is a good strategy, Gayton said. The stubble traps extr moisture, protects the seed from winter wind erosion and provides a sheltered environment as the forage seedlings develop in the spring.

log number 88-21
January 29, 1988.

THE NEW RESPECTABILITY OF KOCHIA

Seldom do we witness the birth of a new agricultural crop. But such would appear to be the case with kochia, a much-maligned annual weed currently under study by the Saskatchewan Research Council (SRC) in cooperation with the Agriculture Canada research station in Swift Current.

Assisted by Saskatchewan's Agriculture Development Fund, through the Economic and Regional Development Agreement, researchers are conducting a broad-based study of the agronomics and feeding potential of kochia. In spite of its weedy nature, says Ewen Coxworth, SRC chemist and head of the study team, it has a number of features that could possibly be of use in Saskatchewan agriculture.

"Kochia can be put up as cattle feed and, judging by the sampling already carried out, its feed value can be as high as that of alfalfa," he says. "It is also extremely tolerant of salinity and may be useful in the reclamation of saline land. And, with a plant growth pattern similar to that of corn, it undergoes spectacular growth when conditions are right."

Because grasshoppers dislike this plant, the potential of kochia extracts as a control method adds impetus to the study. A more immediate advantage is the fact that it is one of the few forages to withstand severe grasshopper infestations.

When grown on the same site for several consecutive years kochia tends to have a very stunted growth. However, farmers and researchers have found that the combination of soil cultivation and adequate fertilizer seems to be the key to continuous production in this situation.

Current research is focussing on: kochia response to nitrogen fertilizer applied at different rates and in different formulation; variety selection from native populations; and livestock feeding trials.

Kochia is widely known to contain some undesirable trace compounds which make it hazardous to feed as a pure ration. However, researchers have found reasonable livestock performance on rations containing up to 50 per cent kochia, and farmers have found no problems feeding rations of a similar percentage to pregnant cows.

Researchers and farmers recognize kochia as a serious weed when it grows in the wrong place, and acknowledge the fact that further work must be done to control its weedy tendencies. Future selections will be based on its non-weedy properties.

Because of the widespread growth of kochia on saline soils in Saskatchewan, many farmers are experimenting with its uses on their own. Last year, a survey of 54 farmers with several years experience growing kochia revealed that almost all were enthusiastic about further development of this plant.

"Although the applications of the quirky kochia plant may yet prove to be limited, it is definitely on its way to becoming a new forage crop for saline soils," says Coxworth.

For further information, contact:

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How Much Kochia Can Cattle Eat?

This year's summer drought will mean that forage and grain for livestock feed during winter will be in short supply and expensive. Livestock Specialists have reported that kochia will be a major source of feed in the coming months for many cattle producers. This is because the drought and saline tolerances of kochia ensured that it was one forage to make reasonable growth during the dry summer.

Research, supported by the Canada/Saskatchewan Economic and Regional Development Agreement, was recently completed at the University of Saskatchewan to determine the levels of kochia which could be fed safely and whether gradual adaption would increase the level while maintaining satisfactory intakes and weight gains.

The research found that kochia could be fed at up to 60% of the diet without any negative effect on feed intakes says Roger Cohen, Animal Science Professor at the University of Saskatchewan. Beyond 60% kochia however, feed intakes fell off very rapidly. Even when cattle were adapted gradually to kochia, 60% was the upper limit. The nitrogen retention by steers from diets with 40 and 60% kochia was 50% less tan from the 100% brome-crested wheat hay fed as a comparison, but still much better than from a 100% kochia ration when almost no nitrogen was retained. Nitrogen retention is a measure of how well the animal is utilizing the protein in its feed. Both intake and nitrogen retention results indicate kochia should not exceed 40-50% of the feed.

A survey of 50 Western Canadian livestock producers, who used kochia to feed beef cows, showed that farmers had found similar limits to how much kochia could be fed. The farmers reported that their cows ate the feed acceptably, made normal weight gains, and produced healthy calves as long as kochia hay provided less than 50% of the diet. A few farmers who tried to feed their cows at a greater level than 50% kochia, reported that feed intakes dropped off, cows lost weight and some developed diarrhea.

Although many livestock producers in Texas have grazed kochia and fed kochia hay without incident, researchers in New Mexico and Colorado have encountered toxic symptoms in cattle fed high levels of kochia. It became a major concern that we know what level of kochia can be fed safely and how animals can be adapted to it. Our research results and the farm survey both indicate that 50% is the upper limit says Roger Cohen.

The nutritive value of kochia can be quite high, says Roger Cohen. However, as with most other forages, it declines markedly from pre-bloom through to maturity. A Texas researcher, Dr. Sherrod, reported that good digestibility and intake with sheep were observed when good quality kochia was mixed half and half with good quality alfalfa.

Kochia can contain some toxic ingredients such as oxalate and nitrate. However, if the level in the ration does not exceed 50%, producers did not report encountering feeding problems. Producers are advised to discuss with the possibility of some of these problems occurring with their animal nutritionist, particularly if they intend to feed relatively high levels of kochia this winter.

For further information contact:

Dr. Roger Cohen, Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon. (966-4134)

Dr. Ewen Coxworth, Saskatchewan Research Council, Saskatoon. (933-5410)

radio release 89-11-5
March 17, 1989

THE PROMISE OF KOCHIA WARRANTS STUDY

Three years of exploratory research has led Saskatchewan scientists to believe that kochia has considerable promise as a high-yielding annual forage for saline soil. A recent project, Drought Proofing of Cattle Feed Supplies With Kochia, is based on this promise. It is supported by Saskatchewan's Agriculture Development Fund.

The project, undertaken by the Western Canada Kochia Association, will be led by Dr. Ewen Coxworth, principal research scientist with the Saskatchewan Research Council in Saskatoon. It will study and develop reliable methods of planting, fertilizing, harvesting and feeding kochia grown on saline and non-saline soils in the Palliser Triangle of southern Saskatchewan.

Coxworth says kochia, under some circumstances, requires about half the water needed by barley to grow a ton of forage. If our climate becomes warmer and drier, drought and saline tolerance in forages could be very important to the stablization of feed supplies in the Palliser Triangle. If his research is favorable, therefore, kochia could become a very important feed source.

Most of the initial research will take place in the Swift Current area, and will be assisted by Agriculture Canada scientists at the Swift Current Research Station. Several on-farm demonstrations and field trials were carried out last year and these will be continued.

(more)

... will be continued.

Measurement of the nutritive and anti-nutritive factors of kochia will also determine the maximization of its feed value for livestock. Its role, however, will be as a winter maintenance ration for pregnant beef cows. At this point, kochia is not recommended as a feed for growing animals.

If research is on schedule, a final report should be available by March, 1990.

(Editors: Dr. Ewen Coxworth can be reached at 933-5400.)

RELEASE DATE: May 27, 1988

Kochia Emerges as a New Forage for Use During Drought

A weed known to thrive in drought and on saline land is starting to receive the research it needs to become an alternate forage crop.

Test results are showing kochia grows well under such difficult conditions and can be fed to cattle as a forage supplement.

"We're working to turn a weed into a useful forage crop," says Ewen Coxworth, a Principal Research Scientist at the Saskatchewan Research Council (SRC). "Our recently completed three-year study of kochia included a survey of 54 farmers who use the plant successfully as forage. There is growing interest in integrating kochia into livestock operations and the need for additional forage is certainly there, especially when drought conditions cut regular forage production."

The kochia study was a joint project of SRC, Agriculture Canada's Swift Current Research Station, and the University of Saskatchewan Department of Animal and Poultry Science. Funding was provided by the Saskatchewan Agricultural Development Fund through the Canada-Saskatchewan Economic and Regional Development Fund.

"Both our research and the survey of kochia users highlighted several attractive features," Dave Green of Agriculture Canada says. "The two main features are its high water efficiency - it does well, once established, in drought conditions - and its high tolerance of soil salinity. Areas of cultivated fields with high salinity levels are often the only places with soil moisture during a drought and wild stands of kochia seem to thrive in these conditions on saline and disturbed soils."

Green says kochia seeds germinate quickly when moisture is available and grow rapidly during the hottest months of summer. "Kochia has been sown as late as July at the Swift Current Research Station and still produced useful amounts of forage before freeze-up."

He adds that kochia is not an expensive proposition for farmers thinking of trying it as a forage crop. "Seed is available through several farm supply sources including the Western Canada Kochia Association at about $2 per pound. Seeding at a rate of three to four pounds per acre followed by packing will yield up to two or three tons of good quality forage per acre even on saline land.

"First time users of kochia should be aware that the plant needs some management to produce good forage. Modest use of fertilizer greatly improves plant vigor and yield, and harvesting at late bud to early flowering stage, rather than later, improves the feed value."

Coxworth says kochia seed from Texas produces plants that do not set seed in western Canada. "Using this seed is an option in areas where kochia is not already common as a weed. Since wild, local, kochia spreads by producing seeds, harvesting wild stands for feed before seed set in late August should help to control wild populations."

Coxworth cautions that kochia should not be used as a full ration forage. "Animal scientists at the University of Saskatchewan found that cattle tolerate it well up to about 40 - 50 per cent of their diet but reject the forage at higher levels. We recommend that farmers have their kochia analyzed at a feed testing laboratory before starting a feeding program," he says. "Kochia should be tested for nitrate and oxalate, plant products which can reach troublesome levels in some conditions."

Coxworth and Green see a potential for developing kochia beyond its present level. "Most farmers using it now are simply taking advantage of wild stands. Kochia research on plant selection and breeding will help change it into a non-weedy crop that can be cultivated and harvested for forage," they say.

-30-

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SRC Publication No. ______________________

Kochia: Weed or feed?

by DAVE BATES

KOCHIA, a weed synonymous with salinity, is suddenly in the limelight, touted as a forage with some potential for cattle producers in drier parts of the prairies.

Interest seems especially keen in Saskatchewan where several scientists, livestock specialists, and farmers are involved in kochia research — everything from feeding trials to biotechnical evaluation of kochia's ability to ward off grasshoppers. (The plant contains something grasshoppers find especially distasteful; efforts are underway to identify the compound and determine whether it can be gene-spliced into crops.)

"Phenomenal" is the word most often used to describe kochia growth this year. With little or no competition from drought-ravaged crops (most of which were not sprayed, either), wild stands of kochia were thick and plentiful in southern Saskatchewan, says Ewen Coxworth, a research scientist with the Saskatchewan Research Council. Kochia was also the only "crop" some cattle producers harvested. That triggered a flurry of requests for more information on feed value.

Oddly enough, feeding kochia is old hat to a surprisingly large number of farmers, says John Hanson, previously the ag. rep. in Moose Jaw and now retired. Last year for the research council, Hanson conducted a survey of cattle producers feeding kochia. He had no trouble finding 50 doing so, and could have interviewed many more, he says. Some had overwintered cows on kochia-based rations for as long as 10 years.

Given the severe drought and lack of other forages, many cattle producers baled wild kochia this year, some probably for the first time. Swift Current livestock specialist Barry Peterson guesses that about 30% of the 4,000 cattle producers in that area will feed varying quantities of kochia this winter. In years past, fewer than one producer in 50 would have even considered it, he suspects. And Bob Klemmer, livestock specialist in the Weyburn area, estimates that 40% to 50% of the 4,300 cattle producers in his region intentionally harvested wild stands of kochia this year. As many as 75% could end up feeding kochia to some degree, he adds, because nearly all forage crops contained kochia as well.

Coxworth points out that kochia contains small amounts of potentially hazardous compounds (oxylates, which interfere with calcium metabolism, and nitrates) that must be diluted with other ration ingredients to ensure cattle do not go off feed or develop some related health problem. A feed analysis is highly recommended, he says. Accordingly, concern exists for those feeding kochia for the first time this year; it is recommended that kochia not exceed 50% of a ration.

Producers surveyed by Hanson reported no serious herd health problems, but they were smart, not lucky, he believes. With little information on which to base their overwintering programs, veteran kochia-feeders started cautiously, introducing cows to small amounts at first, or never exceeding a certain percentage (usually 50%) of the ration, he found.

Surprising, too, perhaps, is kochia's nutrient value. Roger Cohen, a beef cattle nutritionist at the University of Saskatchewan in Saskatoon, describes kochia as nutritionally similar to alfalfa. Cut near first bloom, kochia's total digestible nutrient (TDN) content runs about 58% to 60%; crude protein levels can average between 14% and 18%.

In feed trials, however, Cohen found a palatability problem once kochia made up more than 60% of a ration. He suggests cows be introduced gradually to a kochia-based ration (no timing recommendation yet exists), and that kochia not exceed a 50% to 60% level.

The plant's feed value is the focal point of the Western Canada Kochia Association's (WCKA) promotion program. The Saskatchewan-based organization consists of about 10 scientists and 25 to 30 farmers involved in kochia-related research, including varietal selection from native stands, response to cultivation and fertilizer, alternative uses for both the crop and its seed, feeding trials, and seeding saline soils for both production and reclamation studies.

Some farmers have a hard time accepting the fact that kochia may be the only crop they can grow on saline soils, says WCKA president Darald Marin, a Radville-area farmer. "It requires a big shift of gears for producers who have been trying to take kochia out of their fields and hay crops to suddenly start using it as feed," he says.

More are feeding kochia, though, and Marin is thankful for the change. "A few years ago, attitudes weren't as conducive to using kochia, and alfalfa was going for $100 a ton. As a result, we lost of lot of cattle in some areas."

While not wishing to rain on any-

(Please turn overleaf)

(Continued from page 25)

one's parade, Saskatchewan weed control specialist Doug Billet points out that kochia remains a weed in the minds of most farmers. "In the same manner that kochia is a weed, so is volunteer wheat or volunteer canola to some individuals," he adds.

If kochia establishes itself as a legitimate forage and is treated as such, says Billet, weed-control concerns would be reduced to some degree. Of course, any kochia stands encouraged to grow and later abandoned for some reason could infest neighboring land, he cautions.

Kochia's role in reclaiming saline soils is probably limited, says Harold Steppuhn, an ag. engineer at the federal research station in Swift Current. In some locations, kochia could lower the water table and improve soil structure, perhaps, but he questions whether these changes would be long-lasting.

"There are no guarantees because the year (weather) can make such a difference," he says. "The situation is even more complicated when drought combines with salinity."

Whatever its potential, there's no denying the ability of kochia to thrive where conventional crops won't grow at all. "In the past few years," says Darald Marin, "saline areas were the only land that produced any substantial amount of forage consistently."

Livestock specialist Barry Peterson doesn't see cattle producers having any hang-up with kochia. "Cattle producers are used to feeding cows just about anything anyway," he points out.

"And if kochia can fill in the gaps in dry years," says researcher Ewen Coxworth, "that could be a major contribution to stabilizing cattle production in the Palliser Triangle."

Kochia research findings are summarized in a 4-page bulletin available from ag. reps. and livestock specialists in Saskatchewan. Out-of-province farmers can obtain a copy of the bulletin by writing either Saskatchewan Agriculture, Communications Branch, Walter Scott Building, 3085 Albert St., Regina, Sask. S4S 0B1; or the Saskatchewan Research Council, 15 Innovation Blvd., Saskatoon, Sask. S7N 2X8. Request SRC Publication R-814-4-E-88.

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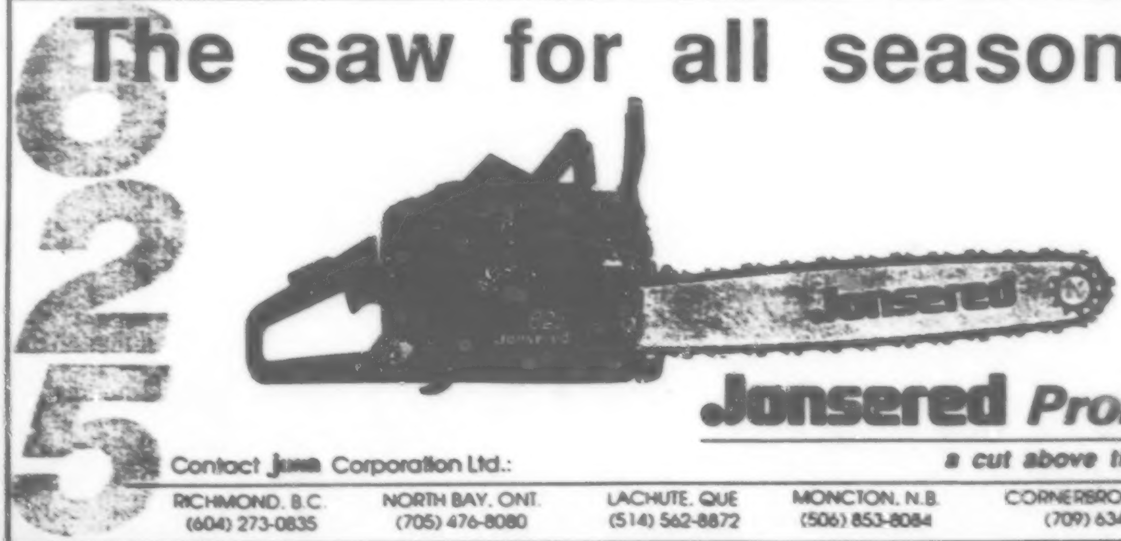

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#4

REVISED
FEBRUARY, 1989.

KOCHIA AS A FORAGE CROP

W.D. CAMPBELL*

INTRODUCTION

Since 1982, experiments have been conducted by the Saskatchewan Research Council and Agriculture Canada as to the feasibility of using Kochia as a forage crop. The interest in Kochia arises from its ability to grow under high salt concentrations, saline soils.

Kochia usually yields in about four tons of dry forage per acre. It also appears that Kochia is fairly drought tolerant and unpopular to grasshoppers. It is not known how well Kochia will yield under non saline conditions, but it is expected that weeds may be a problem. There have been individual farmers who have reported that after growing Kochia continuously for a number of years that the saline land improved to the point where a crop of barley could be grown where it could not grow before. There is, however, no research data to date to substantiate this.

Alberta Agriculture says "Kochia harvested at the mid-bloom stage yields a high quality feed. Care should be exercised with any plant material harvested from saline seeps because it could contain toxic levels of nitrates."

FEED VALUE

There is no doubt that Kochia can be a useful feed. There are recommendations that up to 50% of the maintenance diet of a wintering beef cow can be made up with Kochia. Most individuals feed 20-40%. Care must be taken that ample water is supplied due to the high levels of salts within the Kochia plant. The increase in water intake can also increase urine output which may pose a problem in some cases. Kochia contains high levels of oxaliates, a toxic substance that ties up calcium. This would mean special attention should be drawn to feeding a calcium supplement low in other salts when Kochia is fed. Trace amounts of nitrates have also been found.

Kochia can be fed as a hay crop or a silage. A good quality Kochia hay has been compared to a medium quality grass hay.

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* Field Agronomist, Product Development, Saskatchewan Wheat Pool

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The feed value of Kochia is highest in late bud or early flowering stage (late July to mid-August) and falls moderately by early seed stage (late August to early September) when yields are at their highest. Crimping the hay seems very important to hasten drying.

A typical composition of Kochia is as follows:

Composition of Kochia

	Percent
Organic Matter*	86.8
Crude Protein	10.5
Cellulose	30.7
NDF	51.0
ADF	32.2
Phosphorous	.21
Energy	3.97

* hay crop was harvested August 3, 1983

SEEDING

Kochia is best suited to saline areas already infested with Kochia. Kochia is an annual plant, however, once seeded it can produce enough seed to rejuvenate itself. In order for Kochia to germinate it requires a disturbed soil. The seed must be planted shallowly into a firm seedbed. Be aware of mustard family weeds as flixweed and stinkweed. These are toxic to Kochia and so fields heavily infested with flixweed or stinkweed should be avoided.

Kochia can be seeded a number of ways. One can spread it on to the surface at a seed rate of 3-4 lb/acre (3.4-4.5 kg/ha). A fine layer of soil must then be distributed over the seed. This soil can be spread about by harrows very finely used, or by seeding barley with a double disc or hoe drill after the Kochia was spread. The barley is seeded at normal seed rates for barley. The barley Kochia mix works well as a hay crop. Kochia can also be seeded into the soil with press drills if the low seed rates can be reached. Be sure to seed shallow.

To improve germination of the Kochia seed one should remove the calyx and pericarp from the seeds.

In Saskatchewan, no pure varieties are available commercially, however, some seed growers are producing seed from wild cultivars where no selection for plant types have occurred. A variety from Texas may be available but this will not normally set seed under our growing conditions.

Overseeding of Kochia can cause it to choke itself out.

...3

FERTILIZATION

It is recommended that fertilizer be applied to 50 lb/ac of nitrogen and 20 lb/ac of P_2O_5 be applied to the soil.

HARVEST

Kochia is harvested as you would any other forage crop. It is recommended that Kochia be swathed early to mid-August to insure good quality hay and maximum yields. Kochia cures very slowly requiring at least twice as much curing time as alfalfa before it can be baled.

Kochia residues from previous crops have a self herbicidal effect on the current year's crop. It is, therefore, best to remove as much of the plant as possible.

COMMENTS

If one is to use Kochia as feed, it is recommended that you have it tested by the Saskatchewan Feed Testing Laboratory and follow their recommendations.

In saline discharge areas where the salts gather, a crop that uses high amounts of water is preferred. This is to lower the water table as well as using the water in the top layers of soil thereby preventing the salts from moving to the top. Kochia is a very efficient user of soil water. This means that Kochia can yield higher than barley under normal moisture conditions, yet the Kochia removed less water than the barley (see Table 1).

TABLE 1. WATER USE OF KOCHIA AND BARLEY

Crop	Seed and Straw Yield (kg/ha)	Water used to Produce a kg of forage (kg)	Total Water Use (kg/ha)
Kochia	9,120	275	2,508.000
Barley	2,500	518	3,097,600

Kochia yields do drop in cases of drought but not as significantly as barley. Therefore, under drought conditions it may be possible that Kochia can remove more moisture per hectare than barley, however, studies must prove this point.

...4

If Kochia does not lower the water table then Kochia may be viewed not as a tool in saline soil reclamation, but as an alternative forage crop that yields quite high on saline soils thereby making it economically feasible to grow. Kochia may also be ploughed under to improve drainage and texture of the soil.

There is no evidence that the amount of salt removed by the Kochia is significant enough to be used to "mine" the soil of its salts.

FUTURE

Work needs to continue on Kochia. In the future, effort should be made to increase the acreage of Kochia seeded, promote the crop, and conduct agronomic studies to maximize its yields. If the crop is to be feasible, selection of wild type cultivars must be performed for selection of the appropriate forage cultivar.

For further information contact:

Dr. D. Green	Swift Current Research Station
E. Coxworth and J. Kernan	Saskatchewan Research Council Saskatoon, Saskatchewan
D. Marin	Western Canada Kochia Association Radville, Saskatchewan
W.D. Campbell	Saskatchewan Wheat Pool Product Development Watrous, Saskatchewan

These individuals are looking forward to any questions, comments, or suggestions you may have to offer them.

...5

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ENTERPRISE

PROVINCIAL

Kochia research gets boost

The province is giving $91,000 to the Western Canada Kochia Association for research into using the weed as an alternative cattle feed.

"Over the next two years, research into developing reliable methods to plant, fertilize, harvest and feed kochia grown on both saline and non-saline soils will be undertaken," Premier Grant Devine said Wednesday.

"Kochia's ability to grow under different drought stress conditions also will be researched and the forage crop's nutritional factors measured to determine how to maximize its feed value for livestock."

Saskatchewan Research Council scientist Ewen Coxworth will lead the work. A final report on how to grow, harvest and feed kochia should be available by March, 1990.

Funding to promote research facilities

The province is giving $212,000 to the two university campuses to help them promote their research facilities.

The University of Regina is getting $100,000 to produce publications that encourage use of its facilities. It will also examine its laboratories with an eye to making them more suitable to industry needs.

The University of Saskatchewan is getting $112,000 to prepare research capabilities publications and to prepare an inventory of medical technology.

This inventory will help identify opportunities for commercialization.

The money will come from the department of Science and Technology, minister Ray Meikeljohn said Wednesday.

REGIONAL

Sceptre earnings drop

CALGARY (CP) — Sceptre Resources Ltd. of Calgary has reported 1988 net earnings of $6.3 million or four cents a share compared with $8.3 million or 15 cents a share in 1987.

It said Tuesday the decrease in earnings was attributable to lower prices, higher non-cash charges and a writedown of international properties for four dry holes drilled in 1988.

Sceptre's 1988 gross revenue was $109.8 million compared with $79. 1 million in 1987. The increase was said to be the result of significantly higher production, offset by lower product prices, especially for crude oil and natural gas liquids.

Car dealers get notification today

Thermocare warranties to

By Maureen Marud
of the Star-Phoenix

News of Guardall's financial status has thrown Saskatchew consumers and several dealerships into confusion.

Car service warranties from a company whose assets have been frozen will be honored, the Star-Phoenix has learned.

Guardall Financial Services Inc. of Mississauga, Ont., sold Thermocare extended warranty contracts and Thermoguard paint sealants, rust inhibitors and fabric protectors through car dealers across Canada, including Saskatchewan.

This week the RCMP in Ontario suspended the company's operations pending an investigation of its finances.

A "cease and desist" order from the Ontario consumer ministry has been served on Guardall president, Seymour Ravinsky.

Efforts to reach him Wednesday were unsuccessful. Telephone calls to his offices in Mississauga and Edmonton went unanswered.

News that Guardall's financial status is being investigated and that its assets are temporarily frozen has thrown Saskatchewan consumers and several dealerships into confusion.

Questions they want answered are whether they will be out of pocket and whether car warranties issued by Guardall are now worthless.

The big question being asked by them and the former western regional manager of Guardall is to what extent the company was insured.

"I wonder how much the insurance

fatt of Edmonton, who worked for Guardall until June 1988.

"It depends very much on the value of Guardall's insurance. There are a horrendous number of claims."

He said Guardall's claims were in excess of $25,000 a day almost a year ago.

"Some of those warranties out there are seven-year warranties. It will take a long time to do the run off of business."

But, according to the chief executive officer of an insurance company in Mississauga, the Thermocare extended warranty contracts will be honored.

"Our policies will take care of any warranty holders who end up not being paid if it turns out that Guardall cannot meet its obligations," said Ted Belton of the Pasco International Insurance Company in a telephone interview Wednesday.

Car dealers in Saskatoon who issued Thermocare extended warranties, will be notified in writing today that Pasco will honor contracts entered into before March 21, Belton said.

Thermoguard products (as opposed to Thermocare warranties)

claims on these are ex
minimal, according t
ers.

Car dealers that w
calls from customer
purchased these produ
Acura, Sherwood Chev
Dale Tingley Nissan
Tingley Motors, and S

"A considerable num
tracts have been sold
dealers in the city,"
Gray, service manage
Centre on Circle Drive

These could have be
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Pioneer Life Assuran
ny of Regina will hono
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Paul Hartman, directo
rate communications.

"With respect to the
insurance product, cons
fully covered. We will s
claims on all business
written while we were
ers (until March 21)."

Belton said from M
that eventually whate
are identified will be u
the claims.

Ultrasound lets you sort cattle very precisely.

ısound, the "sound doctors use to monitor a a woman's womb, is be- J to measure fat in live

atchewan Agriculture ultrasonic probe which an Norm Kohle uses to : the backfat on an This can help a feeder ı the cattle with the best of fat for slaughter. : measures the fat cover e loin eye in cattle close to finishing. Based on the ultrasonic reading, he can say how the animal would grade if it were shipped immediately.

"The main benefit to a feeder is that he can avoid shipping cattle that will be discounted," says Kohle. "An ultrasound measure lets him make an informed decision on what to do with each animal. He can avoid wasteful overfeeding and dis-

(please turn to page 54)

ıall-size facilities ıy off big for calves

ı care in handling calves, lly small ones, can pay fewer sick calves and leath losses.

n also help them adjust feedlot faster, ready to l gain weight. They are ıdy to take advantage of that improve perfor- such as implanting.

Zaloudeks of Kremlin, ıma bring in a semi load to 300-lb, newly weaned every other week. They king time to handle the gently pays off.

/ run the calves through utes three days in a row, raher than doing all the processing on one day.

This is a lot of work, but it keeps death losses in the newly arrived calves under two per cent. Jim Zaloudek, Mark's father, figures putting weight on a small calf is cheaper than buying a bigger animal.

To handle the small calves, the Zaloudeks have built their facilities to suit them.

The special, downsized chute and alley reduce stress on the calves as well as cutting back on the labor required from the

(please turn to page 48)

Mon[illegible] State [illegible]versity says after seeing the results of a study on early weaned beef calves. USDA scientists at Miles City found early weaned calves gained 2.07 lbs a day on whole barley, 2.2 lbs a day on rolled barley and 1.76 lbs a day on oats.

[illegible] shows that readily available feed grains can be fed with a minimum of labor and still have satisfactory growth on early weaned beef calves."

The scientists used 67 calves at an average of 82 days of age. They divided them into three groups, feeding them whole gain between steers and heifers. Their grain intake increased as they continued through the feeding period. Grain made up 86 per cent of the total feed energy consumed while forage accounted for 14 per cent.

(please turn to page 51)

[illegible]

Kochia provides grazing and salinity control

Saline areas produce so well on Dick Middleton's farm near Vulcan, Alta. that he has to point them out, even to neighbors.

In this drought year, one solonetzic patch has produced its best crop ever — three tons of silage to the acre.

Middleton grows kochia weed on his saline land, and feeds it to his cattle either as pasture or silage. "It's a dream come true, in a way," he says. "It's the highest protein feed you can get — at least as good as alfalfa. And it has all the minerals the cattle need." It's been the main feed source for his cattle for the last five years.

He credits a course in holistic resource management, given by Stan Parsons, with changing his attitude towards kochia. "I started thinking," he says. "Why keep fighting what grows naturally on the land?"

Middleton still seeds some conventional crops — fall rye, for example — and tries for a crop. If there's moisture, and the rye grows, he sprays the kochia. But if it turns out another dry year, he'll let the kochia grow.

Zero tilling, as he does on most of the farm, isn't good for kochia, Middleton has found. He works his saline areas to be sure he has a good crop of

(please turn to page 51)

Dick Middleton moves his cattle into new kochia pastures every few days.

sitive to some metals. The For example. [illegible] cost

Kochia

(continued from page 45)

kochia.

This year, some of his kochia plants were three feet tall when he put the cattle in there. The cows ate the tops off first and then the side branches, leaving behind the coarse, upright stalks.

A more recent control measure is growing alfalfa on a hilltop. An Alberta government and PFRA map of water movement showed it was a source of salty water, so Middleton put in 100 acres of alfalfa. "It's slowed down the growth of a vast saline area enormously," he says. "Mostly it's been the neighbor's land we've helped. But we got a crop of alfalfa to sell."

Had it not rained, Middleton planned to cut the stalks off fairly tall and put them through the forage harvester, leaving them in a windrow for the cows to eat. He figured the standing kochia stubble would make a good snow trap that wouldn't roll against the fence like a whole plant.

Middleton didn't have to follow this plan through. Some rains came. The kochia grew back so well after each little rain that every time it rained, he was able to bring in a few more cattle. By September, he had 600 cattle grazing on a half section.

He uses small pastures and keeps the cattle in them about three days. It takes that long, he says, to get the cows to eat the Russian thistle. But any longer and the calves start to go downhill.

"Cattle do really well on kochia," he says. "I grow less and less afraid of it as I work with it. And, I'm sure we're helping the land. Kochia has a high salt content, so we're moving the salt away from the salty area."

As cattle feed and as a crop for saline land, Middleton rates the sweet clover he grows as "okay," but kochia, he says, is "great." As silage, he says the cows prefer it to grain silage. Their favorite silage, though, is that made from Russian thistle.

—H.M.☐

My customers ins

The customer is king at a custom feedlot, so John Thiessen of Lethbridge works hard to keep every customer happy. He has customers who insist on Unifeed.

He uses steam-rolled grain. "It's an open, palatable feed so it's easier to get the cattle started on feed. And they eat more, so they gain faster with better conversion. We also have fewer indigestion problems because the rumen doesn't get saturated with fines."

Thiessen believes Unifeed complete feed is a good investment. "You can run into a real mess if you don't mix in the fine ingredients well enough. You need 6000 to 8000 head to justify the sort of mill

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RURAL COUNCILLOR

Vol. 24, No. 5, 1989

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~~F. Warkentin~~

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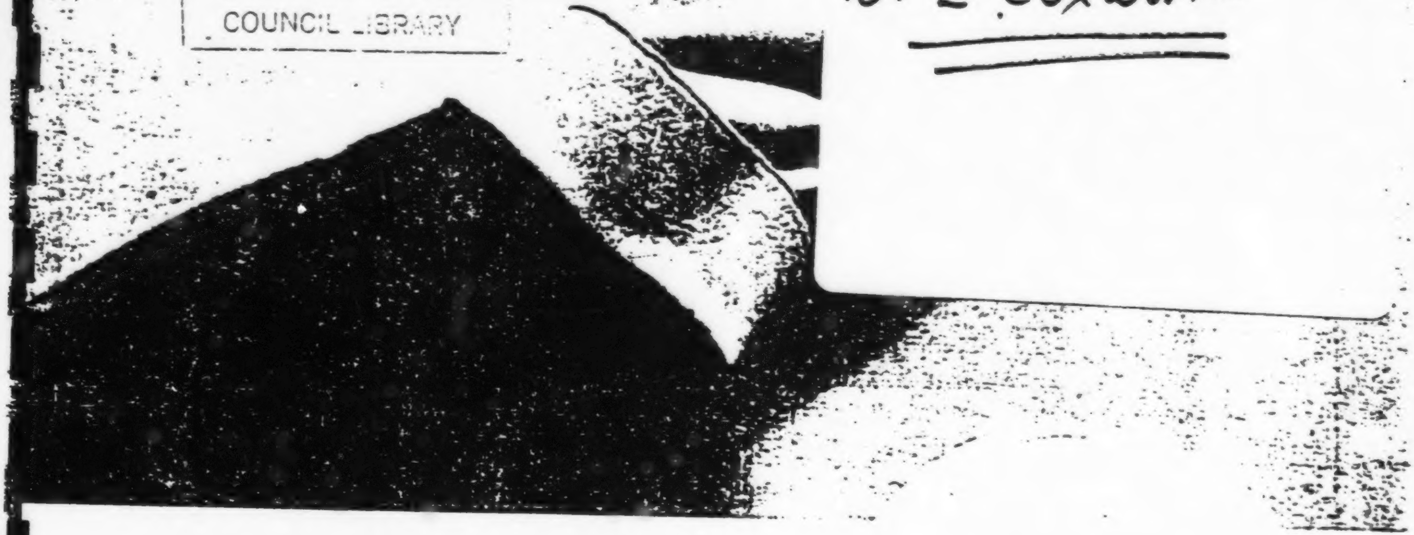

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Volume 24
No. 5

Pasture Productivity in S.W. Saskatchewan in 1988

by Neal Holt
Canada Agriculture Research, Swift Current

In 1988, dryland pasture production was the lowest in this decade. As a result of the drought, seeded pasture production was 25% of normal and livestock on native range grazed the carry-over from 1987.

The year 1988 will be remembered as the year of the drought in SW Saskatchewan. Below normal precipitation in the fall of 1987 was followed by below average precipitation in every month of 1988 except June and September. Coupled with the drought was the effect of wind and high temperature which produced record soil and plant moisture loss (evapotranspiration) in every month of the growing season. Growth of perennial grasses was greatly reduced or did not occur in many exposed areas. Initial growth in March had turned brown by April and little regrowth occurred until September as the drought persisted throughout the grazing season.

At the Research Station, seeded annuals, introduced grasses and native range were grazed at various times throughout 1988 to provide pasture for the station cows, calves and yearling steers. Russian wildrye (RWR) or crested wheatgrass (CWG) produced 18 lb/ac of total liveweight production (TLP) by the calves when grazed by cow-calf pairs in June or July. The calves gained 2.3 lb/day. One acre of grass supported the grazing of a cow-calf pair for 8 days, or 3 animal unit days (AUD) per acre. This is 25% of normal production of RWR or CWG for spring or summer use. In September and October when some new growth appeared, the TLP of RWR was 25 lb/ac by the calves with 9 AUD/ac of grazing by cow-calf pairs. The calves gained 2.9 lb/day.

A number of pasture trials were conducted off-station in large fields of RWR, CWG or native grasses. To estimate TLP, calves of cow-calf pairs were weighed when placed in a pasture and again when removed. In one such trial at Swift Current, total production of CWG was 24 lb/ac and the calves gained 2.8 lb/day. Grazing time was 8 days/ac by the cow-calves. Swift Current - Webb PFRA pasture benefited from a large summer rain and stocking rates were greater on CWG. However, at Gull Lake PFRA pasture, there was little or no growth of any grass species and grazing was provided by grass carried-over from 1987. Calf gains of 2.4 lb/day were good for this year but TLP was 11 lb/ac and grazing time was 4 days/ac on CWG - native grass fields.

Pasture productivity was higher at Auvergne-Wise Creek and Masefield PFRA pastures than at Swift Current. Fertilized RWR produced 34 lb/ac of calf gains and 19 AUD/ac grazing for large (cross-bred) cow-calf units. Adjacent fields of RWR not fertilized produced one-half as much grazing. Native fields of mixed prairie averaged 11 lb/ac of TLP and 5 AUD/ac of grazing for cross-bred cows and calves. Production of a native range at Masefield was similar. Calves gained 2.3 lb/day in these fields.

The year 1988 as a grazing season will be remembered for the low productivity and as a result the shortage of pasture, and the value of the carry-over grass as drought insurance. It will also be remembered for the good calf quality and calf gains on pasture.

The assistance of the SW Forage Association cattle producers, PFRA staff and Research Station staff and funding by Canada - Saskatchewan ERDA make this work possible. •

Kochia Research Project Funded

Premier Grant Devine announced more than $91,000 in funding to the Western Canadian Kochia Association.

The money, from the Agriculture Development Fund, will finance work by the association in a project entitled Drought Proofing of Cattle Feed Supplies with Kochia.

"Over the next two years, research into developing reliable methods to plant, fertilize, harvest and feed kochia grown on both saline and non-saline soils will be undertaken in the Palliser Triangle area of southern Saskatchewan," Devine said. "Kochia's ability to grow under different drought stress conditions will also be researched and the forage crop's nutritional factors measured to determine how to maximize its feed value for livestock."

The work will be led by Ewen Coxworth, principal research scientist with the Saskatchewan Research Council in Saskatoon.

"Exploratory research between 1985 and 1987 showed kochia had great promise as a high-yielding annual forage for saline soils," Coxworth said. "Kochia requires about one-half the water needed by barley to grow a ton of forage."

"Timely rain last July produced good quantities of kochia and it is likely many producers used it as part of their livestock feed ration this past winter. Drought and salinity tolerance in forages are very important in stabilizing feed supplies in the Palliser Triangle, and kochia could become a very important feed source if our research is favourable," Coxworth said.

Most of the research will take place in the Swift Current area with the assistance of Agriculture Canada scientists at the Swift Current Research Station and will include agronomic studies and on-farm demonstrations. Many such field trials were carried out last year and producers used kochia to feed their animals quite extensively.

A final report on how to grow, harvest and feed kochia, complete with a survey of farmer users of the forage crop should be available by March, 1990.

The Agriculture Development Fund, begun in 1985, is a $200 million provincial government initiative geared to improve agriculture in Saskatchewan. •

Spectroscopy may predict metastatic cancer

by Léo Charbonneau

TORONTO—Nuclear magnetic resonance (NMR) spectroscopy, a 30-year-old analytical chemistry technique, is showing promise in the identification of metastatic potential in some cancers.

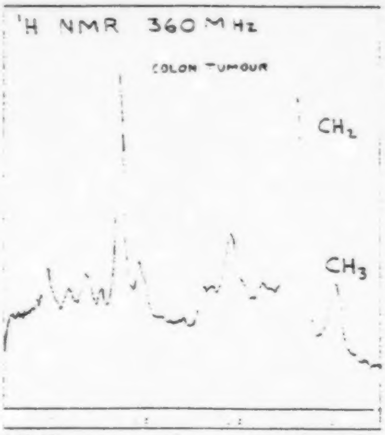
Conventional dogma held that spectroscopy was of little use in examining tissue, but five years ago Dr. Carolyn Mountford, now at the University of Sydney in Australia, discovered that rat tumors gave excellent NMR spectra. She also found that the speed at which these spectra decay is related to metastatic potential. Rapid decay means a tumor is non-metastatic, while slow decay presages a metastatic cancer.

Another university had fired her for her efforts.

Dr. Ian Smith, director of the National Research Council's biological sciences division, met Dr. Mountford while on a speaking tour of Australia, confirmed her work, and is leading the research in Canada. He presented his findings here at the third Chemical Congress of North America.

The two researchers theorize that the spectrum is so clearly defined because it measures an antigen on the cell surface—a completely unexpected result. "All cells have personality markers out there, and what I think we are seeing is a unique cancer cell antigen specific for this type of cancer," he said. Of course, there are many types of cancers, and hence each type will have to be characterized to determine its specific spectroscopic behavior.

Dr. Smith has applied the technique to human tumors. Over a three-year period starting in May 1985, the excised tumors of 200 patients with adenocarcinoma of the breast or colon were studied. Twenty-seven produced quick-relaxing spectra, while the rest had long relaxation times, indicating potential metastasis. The research was conducted in co-operation with the Ottawa General Hospital and the Ottawa Civic Hospital. Costs of about $50,000 a year were picked up by the NRC's division of biological sciences.



NMR spectra of rat tumor first obtained by Dr. Mountford in Australia. Peaks of interest are marked CH_2 and CH_3.

None of these 27 patients had metastases at the time of surgery, and none have developed any since. However, since the technique is experimental, all patients were treated with chemotherapy or radiation regardless of the spectroscopic diagnosis, which may partially explain the otherwise spectacular true-negative rate.

On the other hand, of those patients proclaimed to have a malignant tumor, a number were found free of secondary cancer at surgery. Unfortunately, many went on to develop secondary cancer.

The next step is to make the procedure non-invasive. The tumor would first be localized using magnetic resonance imaging, and a spectrum would then be obtained *in situ*.

"We can image the tumor within the patient without intervention. We then switch over to spectroscopy and measure the spectra and relaxation behavior to determine the stage of the tumor, and if it has any tendency to metastasize. If not, and if it is causing no other problems, surgery or perhaps chemotherapy and radiation therapy can be avoided," wrote Dr. Smith in a press release.

It is easy to add spectroscopic capability to an MR imager, said Dr. Smith, with basic hardware costing about $20,000. Most manufacturers will provide spectroscopy, but charge up to $300,000 to do so, he said.

In related work, Dr. Smith is studying the use of NMR on blood samples. In 1986, Dr. Eric Fossel of the Beth Israel Hospital in Boston announced that the spectrum obtained from blood, which is dominated by fatty components, can be used to predict cancer. If a particular parameter, obtained by averaging two peaks in the spectrum, is below a certain value, then cancer is suspected.

Dr. Smith's group has measured this parameter for some 1,400 patients. His results show that cancer patients do indeed yield a low value, but patients experiencing other problems associated with high fat levels in the blood also yield low values. This augers poorly for use of the method as a general screen, but it may have value for following the results of therapy, he said.

Dr. Smith predicts hospitals will be doing routine spectroscopy within five years.

Common weed used as alternate forage

SASKATOON—A common weed known to thrive in dry and saline land is receiving attention as an alternate forage crop for cattle.

A recent three-year study of kochia included a survey of 54 farmers who used the plant successfully as forage. "There is growing interest in integrating kochia into livestock operations. The need for additional forage is certainly there, especially when drought conditions cut regular forage production," said Dr. Ewan Coxworth, a principal research scientist at the Saskatchewan Research Council (SRC).

The kochia project was a joint effort of the SRC, Agriculture Canada and the University of Saskatchewan, with funding from the Canada-Saskatchewan Economic and Regional Development Fund. The research highlighted several advantages of the weed, including high water efficiency and tolerance to soil salinity (cultivated fields with high salinity are often the only places with moisture during a drought).

Researchers cautioned, however, that kochia should not account for more than half of the cattle diet.

Star Phoenix Monday June 13, 1988 D6

Weed helps farmers fight drought, salinity

By Dan Zakreski
of the Star-Phoenix

Farmers battling drought and salty soil this spring are finding a livestock feed source in the unlikeliest of places.

Kochia, a weed commonly found flourishing in salty patches and slough borders, is emerging as an alternate forage crop.

A three-year joint study by Saskatchewan Research Council and Agriculture Canada included a survey of 54 farmers between Estevan and the Alberta border who use the weed as a feed supplement.

The two main advantages of kochia are its high water efficiency, which gives it a natural advantage in dry years, and its high tolerance to soil salinity, says Dave Green of Agriculture Canada.

"Areas of cultivated fields with high salinity levels are often the only places with soil moisture during a drought, and wild stands of kochia seem to thrive in these conditions on saline and disturbed soils," he said.

Farmers from the study did not set out to use the weed as a forage source.

"I started back in 1979 when I was desperate for feed," said Wes Powers of Parry.

"It was growing so rank on my neighbor's land that I thought it must be edible. That year I got a hay cutter and started."

Powers has relied heavily on kochia in dry years, sometimes using it as a sole feed source.

"I've heard it's not healthy to feed it 100 per cent but it didn't hurt my cattle."

The research council reports that a 40 to 50 per cent kochia-to-feed ratio is ideal.

"Animal scientists at the University of Saskatchewan found that cattle ate and utilized it well up to 40 to 50 per cent of their diet, but reject the forage at higher levels," said Ewen Coxworth of the SRC.

Elmer Doell of Loreburn inadvertently discovered the weed's feed potential six years ago.

"There was a slough with kochia growing on the alkali border. My neighbor wanted the stand cleaned, so we cut and baled it . . . and the cows started eating it," he said.

Doell will dump bales of kochia alongside regular feed bales, "and the cows will move back and forth."

The amount of kochia he uses varies according to the state of his regular feed source, 150 acres of tame forage grass.

"Last year, I hardly used any because the crop was good. But this spring I've got a lot of kochia."

Bruce Hill of Imperial started using it three years ago, harvesting low-lying areas on his land and dumping the feed into a pit silo.

"It's not an exact system. We take what we can get, put it in the bunker, and the cattle eat their way through," he said.

The weed is a valuable addition to Hill's operation because it allows him to use areas that will not support anything else.

Scientists at the Swift Current research station are using a specialized greenhouse this spring to find which plants grow best in salty soil. Between 10 and 12 per cent of prairie farmland is estimated to be affected by salt.

Crops are grown in large plastic tanks of sand and the researchers vary the amount of watering, heating, lighting, ventilation and salt levels.

In addition to looking at kochia, grain crops like barley are being rated for salt tolerance and efficient water use.